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*Paul*

# **Interim Reports**

## **Vol. 2**



Reports on Field Work  
Carried out at Mohenjo-Daro

# INTERIM REPORTS Vol. 2

Pakistan 1983-84  
by the IsMEO-  
Aachen-University Mission

edited by  
M. Jansen and G. Urban

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GERMAN RESEARCH PROJECT MOHENJO-DARO  
RWTH AACHEN

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ISTITUTO ITALIANO PER IL MEDIO ED ESTREMO ORIENTE  
ROMA

Cover: Part of DK-G South Area

Frontispiece: The IsMEO-Aachen-University Mission in  
Mohenjo-Daro 1984. (Photo: Georg Helmes, Aachen)

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### Concerning the contradictory spellings of the name "Mohenjo-Daro"

For this publication, the editors decided not to standardize the spelling of the name "*Mohenjo-Daro*", but rather to accept the different versions submitted by the authors. We therefore apologise for what at first sight appears to be an unsystematic way of writing. While the German Research Project uses the traditional form of "*Mohenjo-Daro*"; as can be found in Marshall, Mackay and Wheeler, other contributors favour a different spelling, such as "*Moenjodaro*", "*Moenjo Daro*" etc.. According to our Pakistani archaeologist, G.M. Shar, the meanings of the different spellings are as follows (Source: *Sindhi-English Dictionary, Second Edition, 1976*): Daro(daro) — دڙو — noun, in all cases meaning a heap or mound. Mohenjo — مهنجو — or Mohonjo — موهنجو — possessive pronoun, mine or my. Moen/Moan — موء — past participle plural of to die, dead. jo — جو — preposition, of, mark of the possessive case. Mohan — موهن — noun, also Hindu name meaning one who fascinates. Epithet of Krishna. We thus have such possibilities as "My mound" or "The mound of the Dead" or "The mound of Mohan". According to the Sind Dictionary, the *Moen-jo-daro* form, with its variations of "*Moenjodaro*" or "*Moenjo Daro*", seems to be the most appropriate.

We feel it is necessary that one generally accepted spelling be adopted and used by all scholars in future works.

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## Preface

With the publication of Interim Reports 2 we present, slightly later than scheduled, contributions relating to the research period 1983-84 at Mohenjo-Daro, the sixth season of the RWTH Aachen Research Project Mohenjo-Daro and the second season of the joint IsMEO Rome/RWTH Aachen Mohenjo-Daro Project.

After two years' participation of Italian colleagues in the RWTH Aachen project at Mohenjo-Daro, a formal protocol of collaboration between IsMEO, Rome and RWTH Aachen was signed on December 14th 1983 in Rome for the duration of two years by Prof. Gherardo Gnoli, President IsMEO, Rome, and Prof. Günter Urban, then Vice Chancellor of RWTH Aachen.

In the meantime this protocol is about to be prolonged for the second two-year period.

On March 5th 1983 a corresponding licence had been issued by the Government of Pakistan for a period of three years allowing Aachen University and IsMEO, Rome to pursue a joint archaeological mission, commencing on January 1st 1983.

According to the application and the licence granted thereafter, the joint venture was oriented more to the development of a research strategy appropriate to the complexity of Mohenjo-Daro than to the mere gathering of further data.

Based on the maps and aerial photographs prepared by the RWTH Aachen Mission during the previous years, non-destructive methods, as had already been developed and tested by the Italian mission e.g. in Shahr-i Sokhta, were therefore developed.

Accordingly, the fieldwork had to be organized along three main lines of investigation: 1. surface evaluation of undisturbed surfaces of the site for craft activity; 2. geophysical prospections of the underground setting; 3. geo-environmental analyses of the site and its immediate surroundings.

The intensive activity of the many specialists involved in this programme allows a systematic evolution of many different methods, forwarding trends for successful collaboration.

Following the original intention, the IsMEO/RWTH project provided new research perspectives adjusted to the particular state of Mohenjo-Daro as a restricted archaeological site.

Its surface and subsurface can be studied in many different ways, still involving large bodies of data, by restricting observations to a limited area or class of materials, with the highly analytical capacity of a computer-based unit for recording and evaluation available in the field lab. The kind of object to be investigated, the field of observation and the means of employment have to be selected carefully before the ground surface is touched at all. Once on the ground, the most detailed recording scale has to be chosen in order to define the context with the largest possible supply of coherent data, whereby a higher level of awareness prevents one from any arbitrary selection. Besides the surface evaluation programme (SEP) the "forma urbis" research has become more and more important.

The study of the excavated remains, and especially the reports on the deep diggings, have been the primary sources for the analysis the vertical extent of the site up to the present. Drilling profiles and geophysical investigations carried out within the IsMEO/RWTH project have contributed to a better understanding.

In general, the research results have shown that there is a strong interdependency among the different approach strategies, which represent an optimized net of coordinated results.

There is no doubt that, once the strategies have been finally worked out, the computer-promoted treatment of collected data will show adequate results, as can already be recognized by first analyses.

The joint working phase began on February 1st 1984 and ended on March 15th 1984.

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As guests we could welcome Prof. Dr. George and Barbara Dales, Berkeley, Prof. Carl and Martha Lamberg-Karlovsky, Harvard, Dr. Jean-François and Catherine Jarrige, French Mission to Pakistan.

We are thankful to:

- the Director General, Department of Archaeology and Museums, Karachi, M. Ishtiaq Khan, and the Director Administration, Sh. Kurshid Hasan;
- the staff of the Department and Mr. I. H. Siddiqui, Curator of Mohenjo-Daro;
- the Pakistan Tourist Development Corporation (PTDC) for having rented us their bungalow in Mohenjo-Daro, which served as camp, with an additional eight tents;
- Prof. Dr. K. Jettmar, Heidelberg, for borrowing his jeep;
- all our worker-men and friends in Mohenjo-Daro.

Special thanks are due to Mr. Masood Khuoro, MP, Provincial Parliament and Chairman of the District Council, Larkana, for all his generous help and for storing our research luggage.

RWTH Aachen Mission

IsMEO Rome Mission



## Preliminary Results on the "forma urbis" Research at Mohenjo-Daro

Michael Jansen  
Aachen

1931 (Marshall 1931). This plan is basically a topographic map, as is the "Wanzke-plan", prepared in 1979 for the ARPM and which is for the time being the reference map for all other studies.

Based on the Piggott-plan a hypothetical reconstruction of the site was later carried out which showed the citadel as part of a grid-iron patterned "roman castrum" with a squarish groundplan of approx. 1028 by 1211 meters.

Interestingly enough there are reports on structural remains outside the daros (Marshall 1931: 9) from the very beginnings of excavations at Mohenjo-Daro.

Recent reports by farmers from nearby villages indicated the presence of brick structures 3-4 meters below the surface which had been uncovered during the construction of wells.<sup>1</sup>

In 1981-82 M. Cucarzi was invited by the ARPM to carry out geophysical tests to trace underground structures, a program which in 1983 became part of the ARPM Aachen/IsMEO Rome project. A southern limitation of the inhabited site already discussed and anticipated in 1981-82 seemed to be proved by an approx. 400 m long geophysical anomaly which was interpreted by Cucarzi as "part of a mud-brick platform" (Cucarzi 1984: 195).

The "platform thinking" is nothing new for Mohenjo-Daro. On the contrary, it was intensively discussed in the sixties stimulated by Raikes' "flood theory". According to this theory the inhabitants of Mohenjo-Daro had started to construct platforms in the later urban period as an emergency programme against the rising flood waters of the Indus which, according to this theory, had been dammed through tectonic movements near Sehwan and which caused Mohenjo-Daro to slowly submerge.<sup>2</sup>

Under these circumstances the platforms would only have been a secondary appearance as a counteraction to floods endangering the settlement.

In a logical continuation of its documentation project on the excavated remains at Mohenjo-Daro which began in 1979, the "Aachen Research Project Mohenjo-Daro" (ARPM), RWTH Aachen, began in 1983 with observations for the study of the "forma urbis" of Mohenjo-Daro, the first results of which were published from 1985 onwards (Jansen 1984b, 1986b, 1987a, 1987c).

It was primarily stimulated by the still unpublished drawings and records of Wheeler's deep digging in 1950 west of the "granary", furthermore by the observations made between 1979-1982 during the construction of the collector-drain around Mohenjo-Daro (Save Mohenjo-Daro Project), where in several areas outside the anticipated city walls archaeological remains were cut, by several attempts which were made to reach virgin soil (deep diggings 1927-32, deep digging by Wheeler 1950, deep digging 1965 by Dales) and finally by Raikes' flood theory (1965).

In the light of these observations major questions remained to be answered: that of the horizontal-vertical extent of the architectural remains below the alluvial surface, that of the limits of the urban nucleus and existence of extraurban settlements (suburbs) etc. .

Since virgin soil was never reached through vertical diggings the full horizontal extent of the site beyond the mounds visible at present, which were normally regarded as being the outer limits of the former site, remains unknown.

Only one plan (Piggott 1950: 165), later adopted by Wheeler (1968: 36), indicated an area of the total site larger than that shown in the site plan published in

**The plain, the city and the floods: speculations and calculations.**

Floods as a reason for the abandonment or destruction of settlements form one known branch of the

"catastrophe theories" which were applied in the late 19th and early 20th century in order to explain phenomena of destruction or decline and which had their roots in the biblical "Deluge".<sup>3</sup>

Floods which might have endangered Mohenjo-Daro were first mentioned in Marshall's monography (Marshall 1931: 6) and related directly to its history and stratigraphy (ibid.: 102).

Seven years later Ernest Mackay hesitated to draw conclusions from the flood deposits at Ur (Mackay 1938: 5), but he recognized two floods within the stratigraphic context as being the reason for the repeated abandonment of the site.

In total, observations pro and contra the flood discussion can be differentiated into two categories:

1. those made outside the urban structures,
2. those made within the stratigraphic context of the urban structures.

Ad 1. It is extremely important to observe that morphological conditions around Mohenjo-Daro have changed during the last 4000 years. One fact has to be accepted: the ancient surrounding is buried under the sediments of the river, presumably for at least 7 meters (Jansen, this article) or 15 meters (Cucarzi, this publication). In general, scientists today agree that a process of silting-up has taken place during the last 4000 years at Mohenjo-Daro. Robert Raikes anticipated that this process took place in a very short period (Raikes 1965) while we anticipate a very long, more or less regular process.

In any case, destruction by floods in the upper parts of the city could only have taken place if the floods had reached these areas.

**Table 1**

*Stratification<sup>4</sup> of Mohenjo-Daro after Mackay 1938: XIV.XV based on a datum level of 178.9 ft (54.46 m) a.m.s.l. (DK-G area) with the hypothetical floods*

Late Period				
Phase	Ia	0-3.2 ft	-0.98 m	53.54 m
	Ib	av. 5 ft	-1.52 m	52.94 m
	II	av. 7 ft	-2.13 m	52.33 m
	III	av. 9.9 ft	-3.00 m	51.46 m
Intermediate Period				
Phase	I	av. 13 ft	-3.96 m	50.50 m
	II	av. 15.9 ft	-4.85 m	49.61 m
	III	av. 20.4 ft	-6.22 m	48.24 m
Early Period Plain of Today				
Phase	I	av. 24 ft	-7.32 m	47.14 m
	II			
	III			

Today, the plain around Mohenjo-Daro has a height of approx. 48 meter a.m.s.l., while the average of the lower city lies at approx. 52-53 meter and that of the citadel (great bath) at approx. 54-55 meter, with the highest areas around 59-60 meter.

4000 years ago the absolute height a.m.s.l. of the plain around Mohenjo-Daro were more or less the same as

today (approx. 48 m a.m.s.l.) a flood of approx. 3 meters height would have reached only the areas below the 51 meter isohypsic line of the site.

4000 years ago the plain had been much lower (approx. 41 meter a.m.s.l. as calculated by the author of this article or, according to Cucarzi, 33 m a.m.s.l. with a slow and more or less regular aggregation process<sup>5</sup>) even a gigantic flood rising more than 3 meters in the whole valley<sup>6</sup> would not even have reached the lowest levels (47 meter a.m.s.l.) excavated up to today in DK-G and termed by Marshall "Early I".

Even if we assume the ancient level was at 48 m a.m.s.l. (as it is today) the level of the anticipated "second flood" (52 m) would also have been above that even in the event of a very heavy flood.

None of the levels of the "floods" (the first at 48 m and the second at 52 m) could ever have been reached by water.<sup>7</sup>

It has to be mentioned here that neither a regular horizontal growth of the city, as indicated by the stratification of Marshall/Mackay, nor real flood deposits separating one stratum from the other can be identified in the city. This stratification based on regular horizontal growth has been outdated now for a long time (see e. g. Jansen 1984b). A revised stratification, at least for DK-G, is under preparation by the author.

As long as we cannot clearly identify different phases and periods we cannot identify "flood deposits" separating them.

The morphological analysis of sediments (Dales, G., Raikes, R. 1986) and their primary/secondary position within architectural context plays an important role but cannot be discussed here. However, it is anticipated, based on longterm observations, that the sedimental material identified within the architecture as "flood-deposits" is not in primary but in secondary position.<sup>8</sup>

**The vertical extent of the site: the question of the "many cities".**

From the very beginning of their research the excavators were keen to reach virgin soil. Several attempts at deep digs can be recorded (see Jansen SAA 1985 in print: plate III) (Fig. 1) a few of which are listed below:

Table 2

—	VS-area	1925 DD 1-4 (Marshall 1931: 223, 227, 231, Jansen SAA 1985 in print)
—	DK-G	1932 (Mackay 1938: 42-45, Pl. XV, Fieldbook for the year 1932 No 1-123, Karachi)
—	Citadel	1950 (Dales; Kenoyer 1986; Jansen SAA 1985 in print)
—	UPM site	1965 (Dales; Kenoyer 1986)
—	a well in SD	1986 (Ardeleanu-Jansen, under preparation)

In addition to these data, reports on drilling by WAPDA (Khan 1973: 135) are available and show "bricks and pottery" down to 70 ft below surface (approx. 25.70 m a.m.s.l.) in the "old site".<sup>9</sup>

As fig. 1 and table 2 show, the deepest dig (Fig. 1, No 2) in VS area goes down to 42 m a.m.s.l. Sahni (Marshall 1931: 223) thus writes: "A small plot, 25 by 30 ft (DD2 in the plan), to the south of this house was dug down to a depth of 36 feet below the surface, where water was reached, but not the virgin soil. The excavation revealed the existence, superimposed one above the other, of structural remains belonging to the three latest cities<sup>10</sup> and remains of other structures underneath them . . . ." In the lowest levels an animal jaw and teeth, two terra-cotta phallus-like objects, a flat triangular terra-cotta tablet, and two pieces of conch shell (VS 3137-40) were found 36 feet below the surface.<sup>11</sup>

The entry in the field-book (VS register) gives the date as 24.02.26 and the square 30y/8. The objects are described as follows: 3137: jaw bones and teeth, 3138: 2 chessmen of t.c., 3139: a small earthen vase, 3140: a flat triangular object and pieces of bangles.

The report on deep dig No. 1 (Fig. 1; Marshall 1931: 227-8) seems to be more informative: "The excavation soon revealed the existence of a deep infilling of sun-dried brick laid in regular courses, which continued as far as 21 feet below the surface of the courtyard, where water was reached rendering further digging impossible."

Lowest levels were reached on 25.02.26 in square 30aa/18. At a depth of 18 feet (amongst the sun-dried bricks?) a tooth (VS 3163) was again found along with a terra-cotta animal (VS 3162) and a t.c. cone (VS 3164).

At first glance it is surprising that in DD1 water was reached at only 21 feet, while in DD2 it was reached at 36 feet, a difference of 15 feet.

Not the horizontal location (DD1 is located at the western edge of VS-area), but the elevation (through levelling of the Aachen project) provides the answer: the surface of DD1 lies more than three meters below that of the other deep digs. Furthermore, the position marks a western limitation which might be similar to that found by Wheeler in 1950 west of the "granary", where he discovered a huge mud-brick wall below the surface.

Mud-bricks are also reported from deep dig No 3 (Marshall 1931: 225) but only down to 6-7 feet. "A rectangular pit, 30 feet long from east to west by some

12 feet wide, was sunk to the depth of 6 to 7 feet through the filling but disclosed nothing of interest."

During deep digging in the stupa area B. L. Dhama, under the supervision of John Marshall, came across a "lofty platform" (Marshall 1931: 125) below 19 ft.<sup>12</sup> "The intervening space is occupied almost entirely by crude brick or alluvial mud heaped up artificially so as to form an immense platform over the whole of this stupa area . . . For the support of this platform stout retaining walls would be indispensable, and portions of such walls have been unearthed on the east and west . . . The western retaining wall (TT) follows a north to south line immediately below the western limits of the monastery . . ." (ibid.: 125) Even in the lowest levels 40 feet below the buddhist pavement (approx. 43 m a.m.s.l.), which were represented by a "low wall and adjacent pavement" (ibid.: 127), potsherds were found which were "in all respects similar to those unearthed at higher levels" (ibid.: 127).

More informative are Mackay's reports (1938: 42-43) on his deep digs. In the very center of DK-G south (Bl. 7, ho 1) he went down about 40 feet (approx. 35 m a.m.s.l.). He had to cut through a mud-brick platform, the base of which was reached 28 feet below datum level<sup>13</sup> (45.93 m a.m.s.l.). Below it, a layer of rubble consisting of broken bricks, potsherds and rubbish extended down to 35 feet below datum. On March 7th 1931 the sub-soil water was reached at a depth of 38.5 feet below datum (42.74 m a.m.s.l.). Below the filling of rubbish and potsherds Mackay traced "a layer of stiff clay with occasional pockets of grey sand" (Mackay 1938: 44) which, according to him, was the clear evidence of a flood. According to this report, 2.10 meters of potsherd and rubbish filling were followed by a further two meters of mud-brick filling in this area. The fact that the lower filling consisted of potsherds and rubbish seems to indicate that this elevated area<sup>14</sup> was constructed while the settlement was already inhabited at larger scale, thus producing a considerable amount of rubbish.<sup>15</sup>

It is important to mention that remains of only small houses were always found in the lowest levels, one of which Mackay comments on as follows: "From the fact that broken material enters into their construction they were evidently not merely material piled up ready for removal elsewhere, and it seems likely that they were rough shelters thrown up for men who were employed to remove the bricks of earlier buildings." (Mackay 1938: 43) One of these huts was found at a depth of 31 feet below datum (45.17 m a.m.s.l.) on a foundation of rubble, obviously the upper level of rubble on which the mud-brick platform was constructed. At the same level not only the lowest foundation walls of a "large building" (block 10) begin, but also those of the great east-western wall belonging to block 1.<sup>16</sup>

Between these two buildings there ran a drain at 30 feet below datum (45.47 m a.m.s.l.) with a slope to the east. So far this is the lowest proven level of a construction

period indicated by a drain in the "lower city". It coincides in height with the lower drain in Wheeler's cross-section west of the "granary" (Wheeler 1968: opp. 44).

But Mackay wanted to go deeper. By the end of April 1932 he asked Mr. Puri, the later joint excavator of Moneer-site and then custodian of Mohenjo-Daro, to go as deep as possible.

At a level of 37.4 feet (approx. 43 m a.m.s.l.) Puri traced "three courses of sun-dried bricks at one side of the pit" (Mackay 1938: 44) obviously the same level where Mackay saw deposits of a flood, 6 feet deeper (41.20 m a.m.s.l.) "a layer of potsherds was found most of them nondescript in character..." (ibid.: 44).

Some of them were depicted in Mackay 1938: Pl. CXII and seem (besides the small pottery model of a socketed axe) to be familiar<sup>17</sup> within the Harappan context.<sup>18</sup>

Mackay writes: "In general, nothing found in the excavations in the Early strata suggests any break in cultural continuity between the Early and the Intermediate Period..." (ibid.: 44).

### Conclusion of the earliest deep digs

A summing up of the different records of deep digs in the twenties and thirties does not lead to very much, as proper cross sections were not drawn and the descriptions are quite vague. Nor do the few photographed potsherds give proper information about an earlier settlement as suggested by Rafique Mughal (1971: 77ff). Structurally speaking, we have records of mud-brick fillings or platforms in different parts of the site, such as in VS area, but also in DK-G area. No major architectural structures are proven below 45 m a.s.m.l. Platforms can appear in most different forms, as fillings of a single room to elevate one part of the house (e.g. house VIII, HR-A) or to fill large areas, courtyards etc. as shown by the examples in HR-B and DK-G. They can also form a substructure for a house, as is the case in the stupa area below the "monastery", in L-area below the "assembly hall", in HR-A below house VI and in many more examples.

Obviously we are not dealing merely with "platforms", but with quite a complicated system of artificial elevations used for different purposes. The platform in the "stupa" area definitely served a different purpose than that in the deep dig in DK-G.

For Marshall and Mackay, they were all — their different absolute height a.m.s.l. left aside — protections against floods. As soon as one studies the three-dimensional growth of this "giant" in more detail, it becomes obvious that this interpretation of a very sophisticated system of artificially constructed elevations within the urban context is too simple.<sup>19</sup>

### Wheeler's deep dig 1950

Another major source for the study of the vertical extent of the site was Wheeler's deep dig in 1950 (Wheeler 1968).

Wheeler's cross-section shows for the first time stratified layers at the western edge of the "citadel" (ibid.: opp. 44). All in all, three different interpretations of this drawing exist: the original, unpublished<sup>20</sup>, the published one by Wheeler (1968: opp. p. 44) (Fig. 2) and the published one by Alcock (Dales, G.; Kenoyer, M. 1968: 499)<sup>21</sup> (Fig. 3). The most precise one is the unpublished plan.

Without going into greater detail, the following observations can be made:

From the surface (approx. 49 m a.m.s.l.) Wheeler was able to dig down to approx. 41 m a.m.s.l., which coincides with the deepest digging of Mackay in DK-G area (Fig. 1, 12; Fig. 2, Fig. 3). Yet he was not able to reach virgin soil.

If the settlement does not continue west of the "citadel", we have with this "mud-brick bund" the first definite margin between occupied and unoccupied areas which is of paramount importance for the study of the silting-up of the surrounding plain.<sup>22</sup>

Wheeler differentiates between 5 phases? (almost from bottom to top - number 3 and 4 seem to be mixed up (Wheeler 1968: 44) (Fig. 2).

Alcock differentiates between 11 phases? (somehow from top to bottom in a slightly curious way of numbering) (Fig. 3).

Without offering a third system the cross section may provisionally be commented on as follows:

The mud-brick bund seems to have been erected in at least three stages: stage 1: the lowest, smaller part 45 m a.m.s.l. and lower, stage 2: the upper (above 45 m a.m.s.l.) inner extension (2D Alcock), stage 3: the upper outer extension.

The construction of "drain A" (9 Alcock) (if it is a drain) and the "floors" to the west (6-8B Alcock) could have coincided with stage 1. If this was a drain, then the

"floors" might represent layers of a street constructed against the oldest bund.

The construction of "drain B" (if it is a drain, as it has no bottom) could have coincided with stage 2, with another street at the level of approx. 49 m a.m.s.l., repeating the pattern of before. Wheeler's so-called "floors" in the lowest levels are, according to Alcock, charcoal-layers and hearths. But they could also be simple secondary deposits of rubbish.

Whatever the interpretation may be, one fact remains: the structures go down to at least 41 m a.m.s.l. (8 m b.s.) and these structures were not sunk into ground in those days. On the contrary, wherever architecture was constructed, one tried to construct on elevated ground, as was obviously the custom in the active alluvial plain of the Indus.

But pits which must have been located outside the settlement were dug in clay layers for the production of bricks and pottery, as can be found even today in the villages of the region.

If the "mud-brick bund" had been constructed directly on the plain, or even on earlier anthropogenic strata (as seems to be the case in Harappa), and not in a depression, then the ancient plain around Mohenjodaro must have been lower than 41 m a.m.s.l.<sup>23</sup>

If we calculate the amount of clay and sediments for the construction of two platforms, one for the "citadel" and one for the "lower town", based on an average height of 5 m, we receive a figure of about 4 million cubic meters (about 400,000 cubic meters for the citadel) without counting the millions of bricks.

The pits dug for the clay were most probably located close to the platforms, and might have surrounded them. This amount taken into consideration, both platforms could theoretically have been surrounded by a ditch at least 5 meters deep and more than 100 meters wide which, once filled with water, became a sort of moat, and together with the platforms served as a fortification similar to the early-historical cities in the Ganges-plain (e. g. Jansen 1987b: 150; Schlingloff 1969: 106, 118) (Fig. 4). This would explain why no one has ever found fortification walls, and also why pottery fragments and brick-pieces were found at a greater depth. They would represent a secondary position, rubbish which was thrown into the ditches.

Whether depressions outside the settlemental area can be identified as pit areas for the construction of the platforms or as a branch of the Indus (see Cucarzi, this volume) seems for the time being of secondary importance<sup>24</sup> in the hierarchy of questions. But having taken a closer look at traditional settlemental behaviour in lower Sind it seems impossible to me that the Indus, or a branch of it, flowed at a distance of only 10 meters from the site.<sup>25</sup> On the other hand, people used to take clay for their houses out of nearby pits which later, filled with rain-water, became the village pond.

According to common tradition, which can be observed even today in the region, construction material is taken

from places as near as possible.

The densely built houses also point towards a very limited and not easily extendable occupation space, whereas the straight thorough-fares might represent a direct connection between the entrances, which, in our case, would have been ramps, as are reported from Harappa. This may be a reason why at the southern and northern end of "First Street" no city gates have been found, as one would expect for a walled city. Returning to Wheeler's cross-section, one can observe that the "mud-brick bund" had an inner filling which (up to 46 m a.m.s.l.) seems to consist of "mud and mud-brick debris" in the lower part. Only in the upper strata (from 46 m a.m.s.l. onwards) it is possible to observe a substructure of the "granary" made of mud-bricks.<sup>26</sup>

If the structure cut by Wheeler's deep digging continued further on, then it might represent a complete retaining construction of mud-bricks with an inner filling of alluvial sediments, thus forming a gigantic platform on which other structures (as the "granary" shows) were erected.<sup>27</sup>

Another important factor is that the filling does not necessarily have to consist of mud-bricks<sup>28</sup>, which is extremely important to recognize, especially for geophysical surveys, since secondary alluvions cannot be distinguished from primary ones. The case becomes even more complicated if it starts to rain during the period of filling-up the inner space of the retaining wall (400 x 200 m, at least 5 m high).

Who would be able to differentiate between the hydraulic deposits of a mud hole or a little lake thus formed within the retaining wall by a "stagnant water deposit" and "flood deposits"?<sup>29</sup>

Furthermore, an extraordinary infrastructure both for the planning body and also for the executive one<sup>30</sup> was necessary to construct a platform of approx. 400,000 cubic meters. The workers would definitely have built temporary huts for the supervisors on the growing platform, they might even have had a fire at night. All these traces may be visible in a cross-section and could have been found by the excavators of Mohenjodaro as described above, not as strata of different phases over a long timespan but as strata of a very short construction period.

### The horizontal extent of the site: a question of the nucleus and the periphery

First remarks on the extent of the site were made by Marshall (1931: 9). "What extent of ground was covered by this city at successive periods has yet to be determined. On the east and north of the mounds traces of ancient occupation, in the shape of low tumuli or prehistoric potsherds strewn over the face of the plain, can be seen for a space of half a mile or thereabouts, and to a lesser distance on the west and south; but whether these areas were once included in the city proper or were merely parts of its extra-mural suburbs is uncertain. One thing, however, that is clear beyond question is that the existing mounds have been greatly reduced in size by the incessant erosion of their sides, and that the ancient city, therefore, must have extended well beyond their existing limits."

Two agents of destruction were obvious to Marshall: 1. silting-up of the plain through the Indus deposits and 2. erosion.

The results of the interaction of these agents are visible today. Marshall mentions an area of 240 acres (960,000 square meters) (*ibid.*: 1).

Mackay wanted to know more about the horizontal extent of the site. In 1931 he cut several trenches in the periphery of the site (*Fig. 5*) in search of a city wall<sup>31</sup> which might have given a precise idea about the actual size of the city.

One trench cut through mound H (*Mackay 1938: 1*), about 100 meters north of DK-G, brought to light a huge rubbish heap consisting of broken pottery, ashes and humus which could be traced down to approx. 43 m a.m.s.l. where, close to the water table, some traces of masonry were found. Mackay thought this was the municipal rubbish area and thus formed the northern limit of the city. Even in cutting further trenches he did not come across "city walls". Extending further north for about 500 feet (approx. 150 meters, the area where the PTDC guest-house stands today) he came across buildings of good, though now ruined masonry, the foundation levels of which he could not trace due to the water-level reached on January 13, 1931 at a depth of 34.2 feet (approx. 44 m a.m.s.l.). In other trenches (south of DK-G and in the depression between L- and SD-area) he did not find structures, but he found what he thought to be evidence for the already discussed floods.<sup>32</sup>

The first, and up to today the only model of Mohenjo-Daro as a whole has been proposed by Stuart Piggott (1945) and was later adopted by Wheeler (1953: 25) (*Fig. 6*). It shows Mohenjo-Daro as a "roman oppidum" on a rectangular plan, 1211 meters north-south and 1028 meters east-west, thus covering approx. 1,250,000 square meters in total, cut by three north-southern and two east-west streets, thus forming 3 x 4 blocks,

with the "citadel" as the middle western one. It has served in recent times for different reconstructions of the city, e. g. that in the Mohenjo-Daro museum (*Fig. 7*).

The most important information about the horizontal extent of the site was obtained during the last years of our research at Mohenjo-Daro. We received not only reports from farmers in near-by villages who had come across brick walls in the ground while digging wells, but also reports from river people who had seen brick-walls washed by the Indus.

First concrete information outside the limits of the topographic maps came through the construction of the collector drain for the UNESCO-project around Mohenjo-Daro. This drain, constructed at an average depth of approx. 45 m a.m.s.l., cut through archaeological ground (*Fig. 8*) in areas south of the "citadel" (in *Fig. 8* marked I), south of Dales' excavation (marked A), south of the "lower city" (marked C) and east of the "lower city" (marked B). Especially in I, A, and B, structures immediately below surface were cut. The number of structures in A was so enormous, that the original plan of WAPDA had to be abandoned and a loop was constructed around the center of underground structures in A. Surface surveys by the author have clearly shown mature Harappan deposits.<sup>33</sup>

Area C consisted mostly of debris which seems to be an extension of the huge rubbish deposits south of HR-area where no major structures were found.

A further surprise came in 1985 when, about 500 m east of the "limits" of the "lower city", a new dam was constructed by WAPDA. Bulldozers came across Harappan structural remains<sup>34</sup> approx. 2 meters below surface. The area formed by a small hill was covered with blackish nodules, as were known from the surface of Mohenjo-Daro. Here, Mark Kenoyer found wasters of *Turbinella pyrum*, indicating that this place had been used for opening the gastropods. At that time we took some measurements and some levelling of points.

The most recent surprise came this year, 1987<sup>35</sup>, when WAPDA constructed a spur inside the bed of the river Indus, close to a Peer's tomb. Here as well, about 2 km away from the "citadel", people had reported burnt bricks with which they had constructed the tombs of some saints buried there.

During the construction work a huge area, about 200 meters long, of mature Harappan structures was exposed. An emergency excavation under the directorship of M. A. Halim brought to light several rooms, streets, and wells. Several seals were found.<sup>36</sup>

Without giving too many details before the material is published by the Department of Archaeology, this discovery has to be commented on more precisely. Architectural remains seem to continue for almost 2 kilometers, at least to the east of the site. Their uppermost strata are below the present surface of the plain at a slightly varying height of 44-46 m a.m.s.l. They represent the (Late?) urban phase. Some tests

east of area B (Fig. 8, eastern limit of the "old site") show no deposits for some distance.<sup>37</sup>

The major question resulting out of these fragmentary observations is: do these settlement areas belong to the centre of the city, to the "intra-mural" part, or are they suburbs which surrounded the city like satellites? Another question is: were they also constructed on platforms as a protection against the floods?

These questions have to remain unanswered as long as no further data are available.

But it is obvious that with these discoveries a new chapter of research has started, dealing with "platforms" and with "suburbs". A new strategy for such type of research is needed, dealing with macrostructural questions. The bulldozers, through which those discoveries have been made, can also be part of this strategy in helping to remove the upper alluvial layers which seem to hide large occupational areas in the plain.<sup>38</sup>

## Conclusion

Mohenjo-Daro has changed a great deal. It is no longer limited to the good old isohyptic lines as can be seen in the Francis- or Wanzke-plan.

If it was — during its urban phase — a planned platform-based city, then this would indicate an enormous step, not only politically, but also financially and organizationally regarding the effort to construct it. This step would have coincided with the appearance of seals, script, burnt-brick technology, hydrological technology such as circular wells constructed with wedge-shaped bricks, drains and bathing-platforms.

We are dealing with a rather small time gap of not more than 80<sup>39</sup> years around 2400 B. C. where all these elements must have been developed, most probably not in Mohenjo-Daro, but in a place close enough to the active alluvial plain to study the river carefully. It seems that the first urban settlement of Mohenjo-Daro was constructed as a whole in a very short period of only a few years, equipped from the beginning with vertical water-supply systems such as the wells, which could hardly have been constructed later when the city was already flourishing.<sup>40</sup>

Of course, many alterations took place during the history of the city, both horizontal and vertical ones, as can be seen by Wheeler's cross-section and by the

change of orientation systems (see Wanzke, this volume) of which we still know almost nothing.

Despite the great difficulties of reconstructing later alterations, the beginning of the urban phase now seems easier to localize.

The platforms here play an extraordinary role, not only as "founding-platforms", simple artificial elevations constructed as a protection against the floods, but also as an iconographic element of elevating specific areas and structures. And this seems to be the case not only in Mohenjo-Daro, but also in other mature Harappan cities like Harappa, Kalibangan and Lothal. From this point of view, the "citadel" as an urban concept in a mature Harappan context in general, and in Mohenjo-Daro especially, covering here approx. 80.000 sqm, is the largest artificially elevated area as part of a city known in the third millennium.

Regarding our "model" of founding platforms (see e. g. Jansen 1985), the approach was, out of deductively collected research-data, to formulate a dynamic hypothesis which had to be differentiated according to the availability of further data.

Meanwhile a differentiation has become possible through additional research (see *Interim Reports Vol. 3*, under preparation), which more and more substantiates the idea of substructures, the appearance of which the author interprets as an initiative action to mark the beginning of the mature Harappan period at Mohenjo-Daro.

There is still hardly any proof for an earlier settlement below mature Harappan layers at Mohenjo-Daro, which, of course, should not be overinterpreted, as almost no research has been carried out in lowest levels where such indicators are expected to be found.

Regarding the existence of an earlier settlement at Mohenjo-Daro underlying the mature Harappan structures, the question has to be raised whether in principle a settlement in the lower Indus-plain could have existed without being constructed on (artificially?) elevated ground on a long-term basis, which would thus have been permanently endangered by the Indus-floods. Whereas in the Punjab early (pre-) Harappan settlements are reported in the alluvial plain, none are known so far in Sind.<sup>41</sup>

Leaving aside for a moment this discussion, the more interesting question seems to be whether the mature Harappan settlement (the city with an "acropolis" of about 80.000 sqm and the "lower city" with about 800.000 sqm!) was the "invention" of the inhabitants of an earlier settlement at the same place, or whether the locus "Mohenjo-Daro", with or without an existing earlier settlement, was chosen for whatever reasons as "central place" by a recently risen culture of the area, which can be identified by a script, a specific production technology and by specific engineering techniques such as circular wells, drains etc.

Having raised these questions we are back to the old discussion, not only about the location of the "epicenter"

of the mature Harappan culture but also about "pre", "proto", "early" and "mature" Harappan periods.

If the mature Harappan period is marked by founding platforms as a basis for a large scale urban planning<sup>42</sup>, as seems to be the case at least at Mohenjo-Daro (and probably also at Harappa, Kalibangan, Lothal, Banawali etc.), we are dealing with an extraordinary engineering architecture which must have been perfected together with all other mature Harappan elements somewhere in an area close to the alluvial plain, but still beyond the reaches of flood-water, such as the Kachhi-plain, the Gomati area, the Ghaggar Hakra area etc..

The construction of the big cities such as Mohenjo-Daro or Harappa, within the immediate reach of the big but dangerous water-ways as transport media, may have been the "first" action of the already existing mature Harappan culture. In this case, the locus of the big cities was not necessarily the primary place where this cultural development took place, but a secondary one which was chosen for strategic, economic, trade and other reasons. The construction of the cities was based on an already fully developed new technology.

If these assumptions are correct, we are still looking for the starting place or area where, most probably in a rather short period of not more than two to three generations, the mature Harappan culture could have received its final shape, with all known elements, before it started to expand explosively all along the water-ways and along the coastal areas.

It would not be surprising to find that the expansion was based on new means of transport by ship, necessitating settlements close to the river. And this settling was based on the engineering technology of artificially elevated settlements. From that moment onwards there were no longer any limitations to the exploitation of the Greater Indus Valley and to travel, even beyond to foreign countries.

## Footnotes

- 1 The author was able to investigate bricks which were discovered in 1980 in a well at Hasan Wahan village approx. 1.5 km north of Mohenjo-Daro.
- 2 Further drilling in 1985/86 by the ARPM with Pyrkhauser drill did not prove major flood deposits. Results of drycore drilling by M. Cucarzi and his team have not yet been accessible for the ARPM.
- 3 Gen. 7, 17-6, 22.
- 4 Mackay's periodization differs from that of Marshall. According to the "flood-deposits" between Late III and Late II he suggests that Late III should be regarded as the uppermost stratum of the Intermediate Period. According to him "there is also strong evidence that the Intermediate III phase should really be regarded as the last phase of the Early Period" (Mackay 1938: XIV).
- 5 Recent drilling points towards a slow process of aggregation in the vicinity of the site. Final proof can only be obtained by a geological cross section outside the retaining wall in the colluvial zone.
- 6 The width of the Indus valley with approx. the same isohyptic sloping is up to 200 km! the inclination towards the sea less than 1%. Even with a higher gradient (see Raikes 1965) a flood in the plain (not in the riverbed) could hardly have reached that height. According to the Gazetteer of Sind 1907: 11-13 the speed of the river varies, e.g. at Sukkur from 0.5 m/sec in January to 2.8 m/sec in the summer, taking into account that Sukkur is a gorge. The speed in the plain is much lower. The shifting of the maximum rise of Indus water-table from Sukkur (4.20 meter) to Kotri (5.62 meter) (ibid.: 12) takes 17 days over a distance of 455 river kilometers (291 km as the crow flies) which makes an average speed of 0.31 m/sec (455 km) or 0.20 m/sec (291 km). Floods coming from the Himalaya zone would have had to cover a distance of more than 1000 kilometers and an area of approx. 1 million sqkm before they would have reached Mohenjo-Daro!
- 7 Except by the dam anticipated by Raikes.
- 8 E.g. textural appearances of "still-standing water deposits" have been observed in the site after heavier rains or the intensive use of water.
- 9 The 18 inch drill hole shows bricks and pottery between 65 and 70 feet on a layer of sandy clay and sand. This layer of bricks and pottery is separated from the next higher stratum of bricks by 25 feet of clay, 4 feet of sand and 1 foot of clay.
- 10 Sahni had obviously been influenced by Marshall's "three periods".
- 11 Here the surface is at 53 m a.m.s.l., which makes the lowest depth approx. 42 m a.m.s.l..
- 12 Below the lowest buddhist pavement.
- 13 178.7 ft a.m.s.l. = 54.47 m
- 14 One has to be very careful not to overinterpret these data, as we know from other areas that such fillings might have only existed within the limits of one house!

- 15 Even today it seems common use in this area to fill depressions with rubbish and specially with potsherds and bricks, as there is no other material as package or proper foundation in the silty alluvial ground. The huge agglomeration of kiln wasters, potsherds etc. south of HR-area piled in heaps, seems to have been a central storage place for such needed packing material.
- 16 See Mackay, E. 1938: XVa-e.
- 17 For a different point of view see Mughal, R. 1971: 77 ff.
- 18 See e.g. Dales, G.; Kenoyer, M. 1986: 307.
- 19 More than 300.000 level-points have been taken by the German Research Project all over the site in order to allow a three-dimensional study.
- 20 This drawing came into our hands through Leslie Alcock and Maurizio Tosi. To both we are extremely thankful.
- 21 A separate publication on the Wheeler excavation is under preparation.
- 22 As the horizontal silting-up, over a long timespan, against a vertical unit constructed in a short period can be observed here.
- 23 Marshall (1931: 9) suggested a level of the ancient plain "some 25 to 30 feet below its present level". The silting-up rate of the Indus has been calculated at 20 cm/100 years (see Jansen, M. 1979: 42; Gazetteer of Sind 1907: 10).
- 24 Especially with geophysical methods it is almost impossible to differentiate between a natural depression and an anthropogenic one close to the settlement (distance in HR south from the houses to the depression hardly 10 meters). In both cases the filling would consist of colluvial material. Perhaps a drilling profile based on 1 m drill distance might help.
- 25 The Indus is a complex meandering river system with enormous fluctuations of water during the year (in summer 16 times that of winter). No settlement was ever founded immediately to its banks, apart from Sukkur, Hyderabad and Thatta which are in close vicinity of rocky outcrops.
- 26 Exactly the same method of back-fillings can be observed in the cross-section of Harappa (Wheeler, M. 1968: opp. p. 30).
- 27 Investigations by the Aachen University team in 1986 have clearly shown that this retaining wall exists around the whole "citadel".
- 28 The south-western corner of the "citadel", even today more than 7 meters above ground, consists of an outer surface made of mud-bricks and an inner core of pure sand!
- 29 During the winter rains in Mohenjo-Daro in the last years DK-G-area was quite often completely submerged. It took some time before this big mud-hole dried out again. One could easily get stuck in the mud for half a meter.
- 30 This platform could have been constructed by 2000 labourers within 6 months based on an average of 1 cubic meter/person/day.
- 31 The existence of a city wall was already discussed with Marshall in 1931: 44. The existence of defence walls was not only important to determine the limits, but was an ideological question, as can be concluded from the later discussion between Vere Gordon Childe (the peaceful, nonviolent aspect of the Harappans) and Mortimer Wheeler (the grim fort of Harappa and the destruction by the Arians).
- 32 At least for the digging north of the L-area we can state today that this "flood deposit", "a very closely packed clay mixed with potsherds" (ibid.: 3) was the mud-bricks of the sub-structure which interestingly enough were not recognized by Mackay.
- 33 An emergency excavation in this area brought to light an "Iron Age" culture. Publication is awaited.
- 34 This was first recorded by our colleague G.M. Shar.
- 35 Although this should not be part of Interim Report II, I think it is important enough to be mentioned here.
- 36 Mrs. Ute Franke was allowed to assist and to carry out some Pyrkhauser drillings which showed a continuation of anthropogenic material down to three meters (approx. 41 m a.m.s.l.).
- 37 This might support the profile shown in fig. 4.
- 38 In Germany (Aldenhofen Platte) bulldozers have been in use in emergency excavations for several years in order to trace archaeological remains in a pit-mining area.
- 39 Jim Shaeffer also mentions such a period before the final appearance of the urban forms with all their consequences (in an unpublished essay).
- 40 We carried out a well excavation in 1986 south of SD-area (Ardeleanu-Jansen, under preparation) and reached at about 13 m depth (approx. 35 m a.m.s.l.) the watertable without having reached the bottom. Such wells cannot have been constructed in an open pit. A separate book on the water supply and sewage systems is under preparation for the Frontinus-Gesellschaft, Köln.
- 41 Of course this might be due to their submersion in the alluvions of the Indus.
- 42 The mature Harappan sites in Mohenjo-Daro, Harappa and Kalibangan are at least 20-times larger than the largest "early" Harappan site which, besides other factors, clearly marks a complete different settlemental behaviour.

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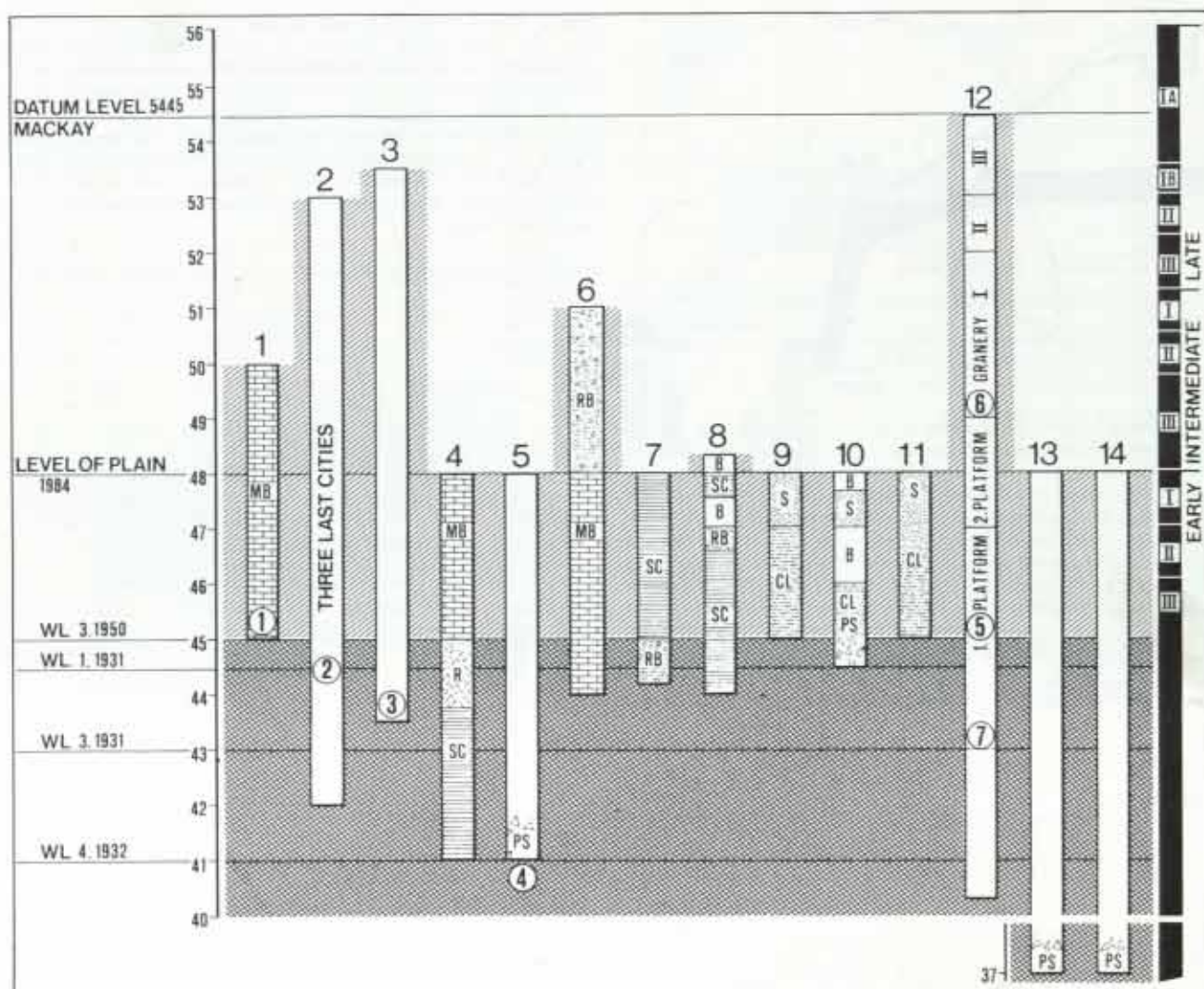


Fig. 1 Diagram showing systematically the different deep diggings at Mohenjo-Daro.

Columns:

- 1 Deep digging VS-area (DD1) (Marshall 1931: 227)
- 2 Deep digging VS-area (DD2) (ibid.: 223)
- 3 Deep digging VS-area (DD4) (ibid.: 231)
- 4 Deep digging DK-G area (Mackay 1938: 43-44)
- 5 Deep digging DK-G area (ibid.: 44). Excavation carried out in Bl. 7, room 3 by K.N. Puri who joined the excavation in Moneer area in 1934
- 6 Trench H (ibid.: 3)
- 7 Trench 574 ft from edge of site (ibid.: 3)
- 8 Trench 40 ft from edge of DK-G (ibid.: 2)
- 9 Trench between DK-G and stupa area (ibid.: 4)
- 10 Trench between L-area and southern face of stupa (ibid.: 3)
- 11 Trench north of stupa, close to site 3 (ibid.: 5)
- 12 Deep digging Wheeler (Wheeler 1968: 44)
- 13 Deep drilling WAPDA (after Aryne 1972)
- 14 Deep drilling UMP site.

Legend:

- 1 terracotta animal VS 3163
- 2 animal teeth VS 3028-32
- 3 remains of structure
- 4 charcoal ashes
- 5 1st street
- 6 2nd street
- 7 "floors"

Abbreviations:

- B = bricks  
 CL = clay  
 MB = mud-bricks  
 PS = pot-sherds  
 R = rubble  
 RB = rubbish  
 S = sand  
 SC = stiff clay  
 ST = structures

The present average level of the surrounding plain in Mohenjo-Daro is reported as approx. 48 m a.m.s.l. (a bench mark is at the museum). The datum level of Mackay's excavation to which also Mughal referred (1971: 77, note 90) is 54.45 m. The different water tables (in the diagram on the left) show high fluctuation especially in the winter months. The cross-hatched part below 45 m indicates the hypothetical first structural phase of the "founding" platform, whereas the hatched part indicates the later additions. The right part of the diagram shows the corresponding stratigraphy according to Mackay (1938) in black.

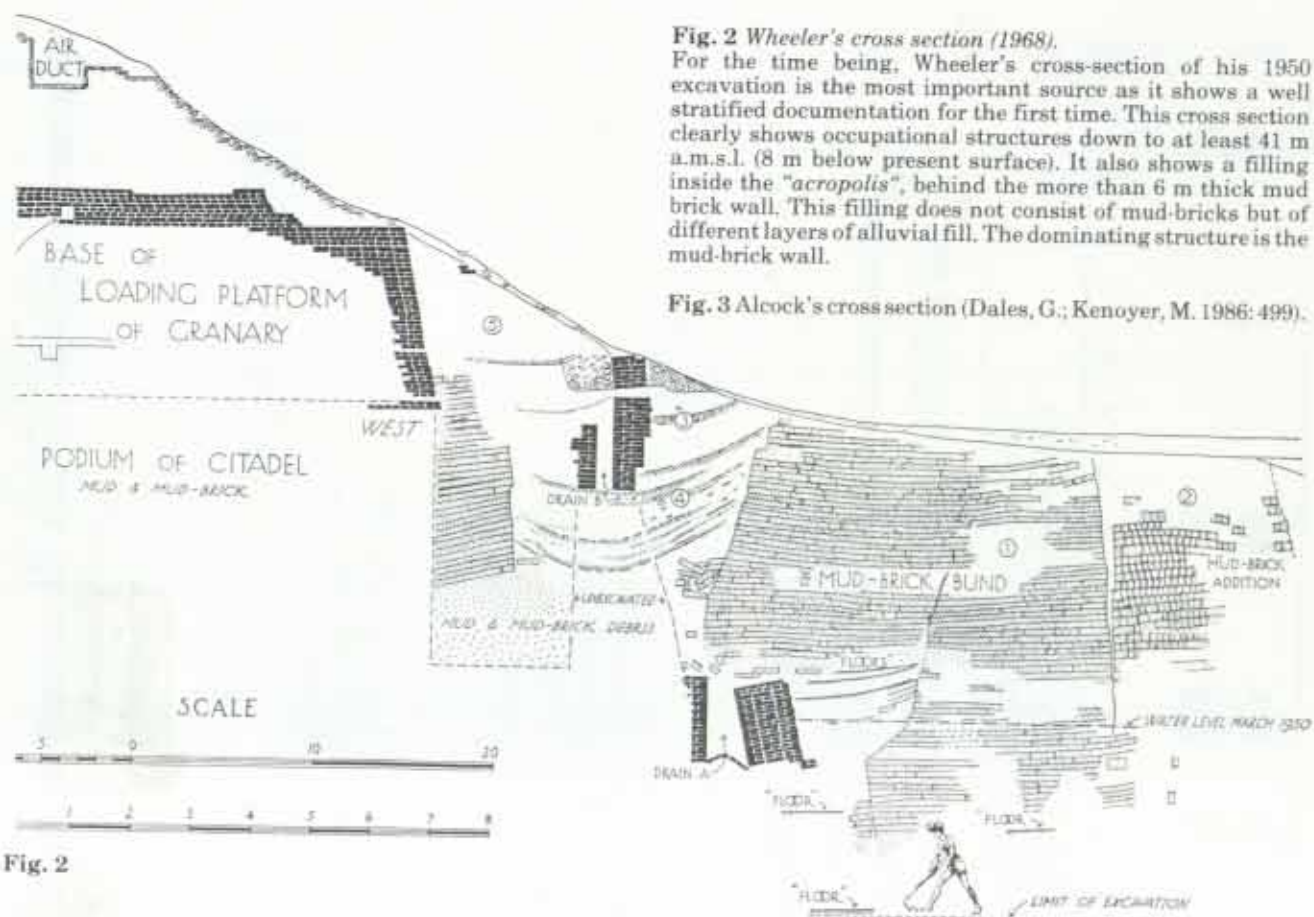


Fig. 3 Alcock's cross section (Dales, G.; Kenoyer, M. 1986: 499).

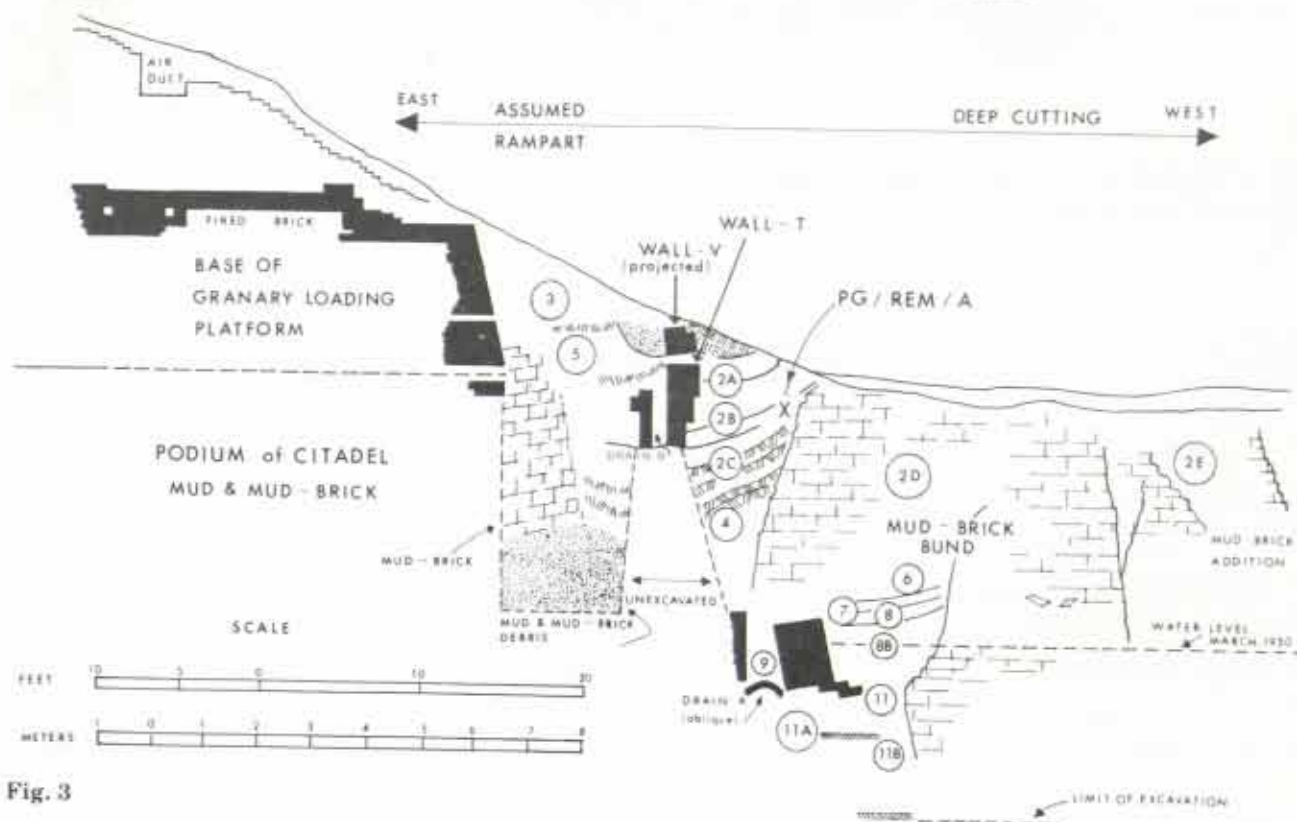
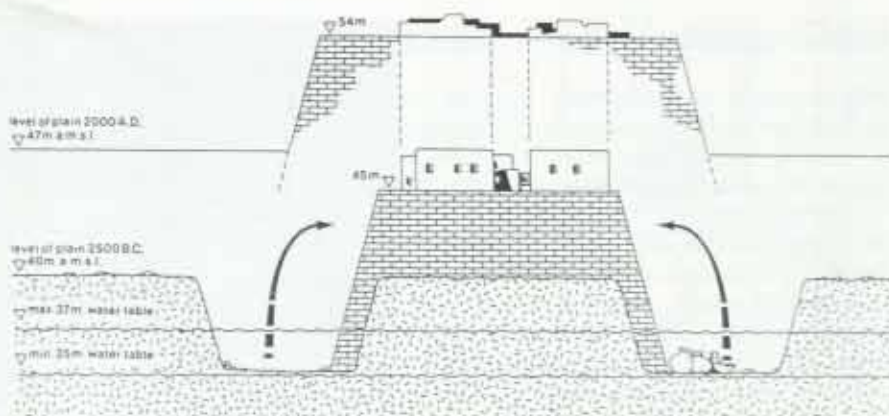


Fig. 3

Fig. 4 Cross-section of the "citadel" area, Mohenjo-Daro.

The drawing shows the cross-section of a hypothetical idealized reconstruction. It is based on the reports of the different deep diggings, especially on Wheeler's cross-section inside the city, and on the hypothesis that the anthropogenic material of the WAPDA drillings is not in a primary position. As Wheeler did not reach virgin soil at a depth of approx. 41.5 m a.m.s.l., it must lay even lower, at least in this locus. Comparative studies of the width-height of the mud-brick wall at Harappa allowed a provisional assumption of 40 m a.m.s.l. for the lowest level of construction, which should be identical with the ancient surrounding of Mohenjo-daro.

Furthermore, it was assumed that the large wall in Wheeler's cross-section represents a retaining wall surrounding the whole "acropolis" area and which was almost simultaneously filled-in in order to form a large elevated area as a foundation for the earliest architecture on top. 400,000 m<sup>3</sup> of earth had to be moved to construct this platform of approx. 200x400 m, which was probably taken from near-by pits, dug to the maximum depth of the ancient water table. The water table, at its lowest in the winter season, might have lain at at least 5-6 m



below surface, i.e. 35-34 m a.m.s.l. (and even deeper). The anthropogenic layers in the deep drillings might be represented through rubbish which was thrown into the ditches at a later date and which are not primary deposits of lower settlement horizons, as has been assumed up to the present. It is difficult to decide whether the pits outside the platform were dug surrounding the whole "acropolis". The concept of a moat is merely conjectural. But 400,000 m<sup>3</sup> of removed earth would e.g. mean a large ditch of more than 50 m width and 5 m depth surrounding completely the "acropolis".

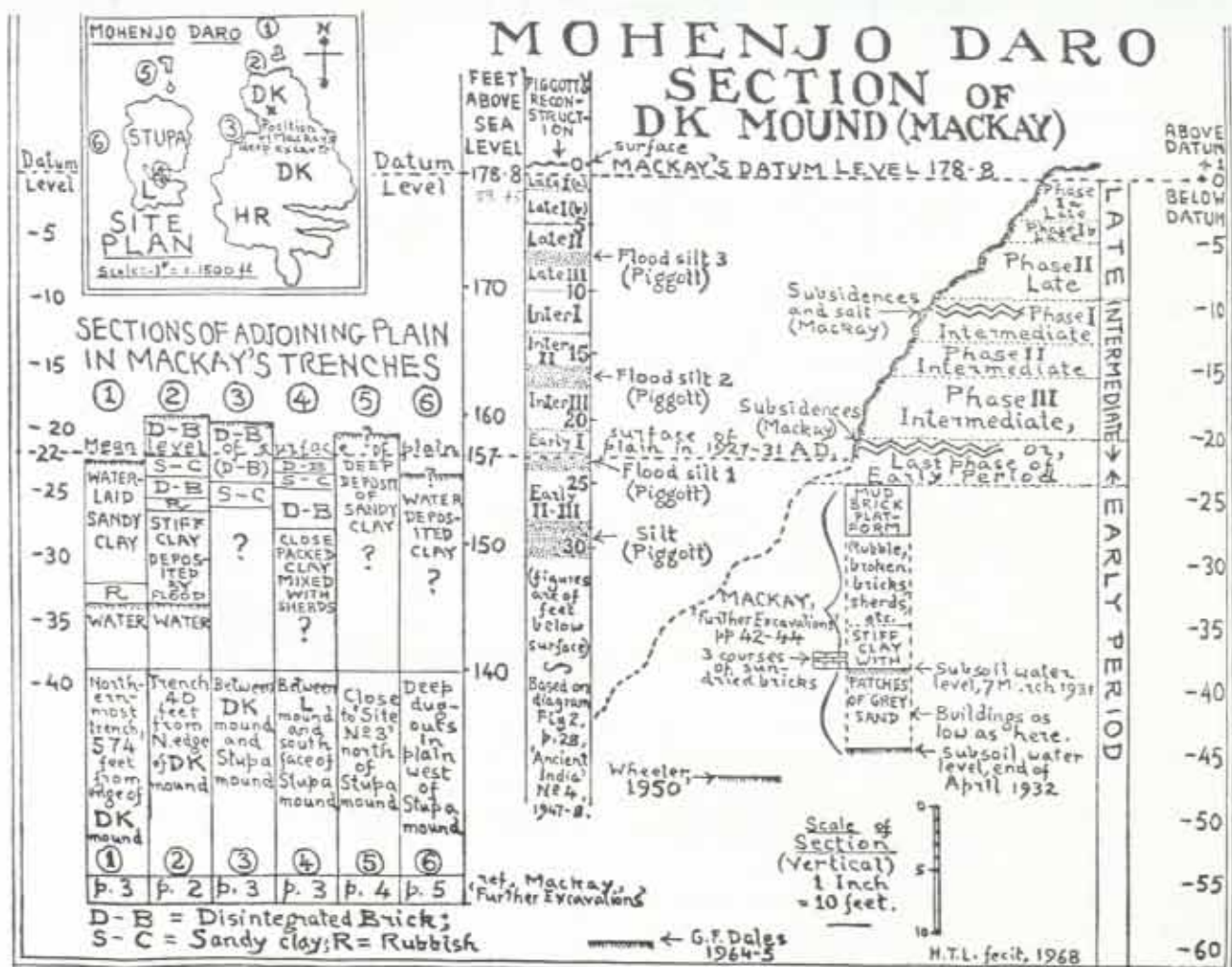


Fig. 5 Diagram Lambrick (1973: 56).



Fig. 6



Fig. 7



Fig. 8

Fig. 6 Reconstruction of the groundplan of Mohenjo-Daro (after Wheeler 1968: 36).

Fig. 7 Drawing of Mohenjo-Daro (Museum Mohenjo-Daro).

Fig. 8 Groundplan showing Mohenjo-Daro, disturbed areas.

# State of Research on the Architecture in "Moneer" Area, Mohenjo-Daro

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*The aim of this paper is to summarize the present state of the investigation of the DK-I or Moneer Area at Mohenjo-Daro. It is based on the analyses and documentary work carried out by the Mohenjo-Daro Research Project under the direction of Dr. M. Jansen, to whom I am indebted for constructive suggestions and advice. Thanks are also due to Dr. Máire Mulloy for translating the manuscript, to Dr. Anna Sarcina, Mustafa Skalli and Friedhelm Pedde for their analyses on the site, and to all involved in the documentation of the MN Area.*

The Moneer (MN) Area (Fig. 1), in the eastern portion of the excavated area of Mohenjo-Daro, is situated approx. 200 m south of the DK-A,B,C Area and approx. 130 m east of the VS Area immediately north of the depression running east-west between the HR and VS Areas (Fig. 2).

With excavated floor and threshold levels of 53-54.5 m above m.s.l the MN excavated area, which extends over approx. 8000 m<sup>2</sup>, lies 5 m higher on average than the surrounding plain. As the circumstances surrounding the "rediscovery" of the site and its identification as the DK-I Area have already been described in detail<sup>1</sup> a brief summary will suffice here.

The MN Area was excavated in Dec. 1933 and between Jan. 14 and Feb. 6, 1934 by Q. M. Moneer and K. N. Puri, Custodian of the Mohenjo-Daro Museum.<sup>2</sup> The site overlaps a trial trench dug in 1923 (Trench D, Fig. 3), of which a few photographs have survived (Figs. 4, 5). Unfortunately neither drawings nor photographs of Moneer's excavations are known to exist<sup>3</sup>, and it is only thanks to Dr. Jansen that at least the handwritten field registers with the lists of finds made in the various excavated areas could be tracked down in the site museum.<sup>4</sup> However, although facilitating general statements on the existence of rooms with a particular function or belonging to a certain class, these registers do not enable the listed finds to be allocated to precise findspots, and thus the information they contain will remain strictly limited as long as sketches of the room numbering systems or other back-up documents fail to the turn up.

The first plans of the architecture of the Moneer Area were drawn up in 1950 by Sir Mortimer Wheeler as part

of his general map of Mohenjo-Daro (scale 1: 476) (Fig. 6). These plans are sources of irreplaceable value as the excavated brick structures relentlessly continue to crumble and the numerous reconstructions are rarely identifiable.

In 1979/80 the Moneer Area was first surveyed in detail and photographed in the course of the work of the Mohenjo-Daro Research Project. The so-called areas (enclosed by spaces such as streets, public squares or unexcavated ground), individual structural units and streets were classified according to a uniform system<sup>5</sup> and numbered (Fig. 7).

In the following years large-scale clearing was carried out with the kind permission of the Department of Archaeology and Museums, Pakistan, as a result of which the areas that had become obscured by wind-blown soil or vegetation, since they were excavated in the 1930's, could be partly restored to their original condition. Among the more noteworthy successes made possible by the clearing operation were the location of a number of street drains and the rediscovery of well preserved mud floors in House B I.

In the 1982 field season those areas which had only been superficially included in the reconstruction and preservation programme of the site were more thoroughly analysed and individual structures investigated in more detail.

In 1984 the two eastern portions, MN-C and -D, were likewise cleared, thus allowing the general plan of the MN Area to be completed by isometric and top views (Fig. 8).

The fact that the MN Area has remained more or less unpublished simply underlines its special position in the architectural analysis of Mohenjo-Daro. The area was particularly fortunate in being almost completely omitted (up to 1979) from the admittedly necessary reconstruction and preservation measures undertaken on a massive scale in Mohenjo-Daro, consequently its structural remains have suffered hardly any secondary alteration.

It is only due to the initiative of Dr. Jansen and the kind cooperation of the Department of Archaeology and Museums, Pakistan, that the restoration work could be brought to a halt in 1979 for the duration of the architectural documentation. Thus the entire areas MN-C and -D are still in their original excavated condition, about 70% of the MN-B Area has been untouched, whereas MN-A and -E have been almost completely renovated and are hence of little scientific value.

In the immediate vicinity of the MN structural remains is the craft manufacturing area investigated by the Italian IsMEO team with the cooperation of the Mohenjo-Daro Research Project. The surface distribution of artefacts and waste products from this manufacturing site extends right up to the eastern

limit of the MN excavated area. It will obviously be interesting to see what results a correlation of the architectural remains and the manufacturing site will bring. The major obstacle in the way of any interpretative study of the MN Area is the totally inadequate documentation of the excavations, particularly in view of the conventional working methods of prehistorians who largely determine classification systems and functions of structural units on the basis of observations made possible by excavation, or at least must rely heavily on the find inventories of individual compartments (Kilian 1984: 37; Heinrich 1982 and 1984).<sup>6</sup>

Without a record of the observations made during excavation it would be more or less impossible, for example, to classify individual compartments as "yards" (characterized by accumulations of rubble and domestic debris, traces of animal husbandry, varying ground structure).<sup>7</sup>

The same holds for statements regarding the chronological relationship between individual structures where clear architectural indications (such as jointly used connections to the street drain system, clearly visible extensions incorporating walls shared with neighbours etc.) are absent.

The interpretation of the structural remains of the MN Area closely follows the theoretical guidelines outlined in the first volume of this series<sup>8</sup> which were adapted to meet the particular requirements of the architecture of Mohenjo-Daro by Dr. Jansen and the Research Project.

The more or less original condition of the excavated structures means that a more exhaustive study can be made of, for instance, the most pressing topic for analysis — the three-dimensional growth patterns of selected structures. This analysis can be expected to produce more reliable information than the investigation of radically restored buildings in the other excavated areas of the site.

As an illustration of the possibilities of such an analysis, an account is given here of a single house unit in the Moneer Area for which plenty of supporting evidence is available.

#### Moneer Area, House B II

The outside walls of House B II (Fig. 9) are bounded on the south by Street E-W-5, on the east by House B I<sub>3</sub>, on the west by House B IV and on the north by House B III (Fig. 8).

At the time of its maximum extent this house covered a total area of 159.60 sqm, of which 51.44 sqm (= 32.23%) are taken up with structural elements (walls, stairs, entrances and passageways) (Fig. 10).<sup>9</sup>

Possible access routes:

- a later blocked-up, narrow passage in the north-western corner (Room 1), leading into a kind of courtyard formed by Houses B IV, B IV<sub>1</sub>, and B III;<sup>10</sup>
- a small passage at the south-western corner of House B I<sub>3</sub> possibly gave access from Street E-W-5 via Room 13;
- a direct entrance into Room 11 from the south, apparently was the principal access route.

The oldest excavated construction phase of this house unit has survived merely as a section of the southern façade a couple of bricks high which was evened up in the following construction phase by means of a levelling layer and used as the foundation for the outside wall of the newer building (Fig. 11). Today this façade is over 2 m high and preserves a number of structural bits of chronological evidence such as blocked-up entrances, levelling layers, or stepped transitions from one wall section to the next above it. The structure built in the following phase (Fig. 12) formed an almost perfect square 11 x 10.5 m in area with a larger central compartment (courtyard?), Room 6, in the north and a smaller one, Room 5 (6 sqm), in the west with a staircase adjoining it on the south which leads upwards from the central room.

This combination of two rooms and a staircase repeats itself not only in a later extension to House B II but is also found in other house units in the Moneer Area, such as A I, A IIa and IIb, B IV and VI<sub>1</sub>, and E I and, less certainly, B V and A XI (the latter presumably incorrectly reconstructed). Obviously this division of space represented some kind of standard element in the groundplans of the house units. As the house types diagnosed by A. Sarcina<sup>11</sup> show, this planning norm is not restricted to the Moneer Area alone. Although her classification of a number of buildings according to type groups can no longer be justified it is worth noting that, of her 112 classified house units 10% have this room — staircase combination in their groundplans<sup>12</sup> (Fig. 13).

It is by no means clear where the stairs led up to; if they led up to the roof or to an upper storey then there would have to have been either a movable or a vanished continuation of the staircase, possibly a wooden construction, or else a ladder. The preserved groundplan of this second construction phase also comprises a long, narrow room in the north-eastern corner of the house which was presumably entered from the west only, as the main doorway to the house (subsequently blocked up) is still recognisable in the southern façade.

It was not possible to determine the layout of the southern rooms in this house unit due to the fact that the floor level in this section is about one metre higher than that of the other rooms. The structures under discussion would thus appear to belong to a later phase in which the building was extended upwards. But prior to this a three-part extension was added on the west (Phase 3), repeating the layout of the adjoining

rooms to the south (*Fig. 14*) — a smaller room in the north-west corner with a staircase immediately south of it, a large central room and a third chamber in the north-east. In this north-east chamber, which contains a fired-brick platform (*Fig. 15*), a large pottery sherd bearing a fragmentary animal figure was brought to light when the floor was cleaned. A similar find has been reported from Street E-W-5 immediately below the effluent outlet of the sanitary installations at the south side of House B IV (*Fig. 16*). The vessel fragment found in House B II may be related to the sanitary installations in House B I<sub>3</sub> and the platform may have been part of the passageway between the two neighbouring Houses B I<sub>3</sub> and B II.

However, there is still a question mark hanging over the vessel fragment found in House B II, Room 3. Wheeler's 1950 plan shows this room divided into three compartments (*Fig. 17*). Yet House B II is situated in a section of the excavated area where reconstruction measures are restricted to the removal of scattered pieces of masonry prior to the insertion of a horizontal damp-proofing course. Either Wheeler's otherwise exactly drafted plan is incorrect at this point, or a few courses of bricks were built up subsequent to the excavation (and later removed) as has frequently been the case all over the site. If such secondary building did take place it would naturally detract from the archaeological credibility of the vessel fragment with animal decoration found in the same context.

Leaving aside the question of the archaeological significance of the subdivision of Room 3, the fact remains that the annexe (Rooms 1-3) blocked up the passageway between Houses B I<sub>3</sub> and B II. It is not clear whether the passageway between Rooms 2 and 6 existed as such, i.e. with the main access at the south, or whether the building was entered at the north-western corner which would not have been blocked up until the entrance to Room 6 was opened.

The following construction phase saw the walls raised higher using parts of the old masonry as a base (*Fig. 18*). This can be seen in the overlaps between the masonry sections built on top of one another in Rooms 5 and 6, in the blocking up of the old entrance and the building of at least one new entrance at a higher level.

By this phase the building had attained its present ascertainable area and proportion. It seems most likely that the main access was from the south; it is no longer possible to decide whether the passage in Room 1 was blocked up by this final phase or not.

The wall built in this construction phase takes up most of the southern façade of the house and still stands to a height of up to 18 brick courses. The blocked-up doorways are still recognizable from the room behind (Room 11), whose excavated floor is roughly level with the thresholds. An accurately laid brick bathing platform is still in place at the same level in Room 11a, drained via a horizontal outlet in the façade.

Immediately beside this is a second sanitary outlet, a sloping effluent chute. Clearing operations in the street beneath these installations brought nothing more informative to light than a couple of bricks (*Fig. 19*). As the search for a possible drain connection of a soakpit cannot be properly carried out without an excavation permit this will have to remain a future priority.

The threshold levels inside the building are slightly lower than those of the two doorways opening directly onto the street. Four interior thresholds (between Rooms 11-9 / 54.30 m above m.s.l.; 9-8 / 54.25 m; 9-6 / 54.35 m; 6-5 / 54.34 m) are still identifiable at their original levels. Other structural features corresponding to these threshold levels include the masonry overlaps in the walls of Room 5 and 6, the threshold of the outside doorway of Room 1, the bottom of the base of the staircase in the south-west of Room 6, and the foundation of the platform and the vessel fragment unearthed in Room 3.

Besides the two staircases in House B II already referred to there is another in Room 11 adjoining a washing or bathing platform. The staircase-platform combination is not merely coincidental, it crops up again and again, e.g. in the neighbouring house units B IV (Rooms 11 and 11a) and BV<sub>1</sub> (Room 13).

Only two indications of the final construction phase have been preserved, i.e. the blocked-up entrances in the southern façade and the remains of a second bathing platform south of Room 13 (*Fig. 20*), the latter just recognizable from its foundations consisting of sherds and overfired lumps of clay. Effluent was presumably drained via the passageway between Houses B I<sub>3</sub> and B II.

The good state of preservation of the structures as excavated has made it possible to analyse not only the sequence of the various construction measures carried out on the house itself but also the chronological relationship of the entire unit to the neighbouring structures, admittedly a complex undertaking. The general direction of expansion within the MN-B Area is east-west (*Fig. 21*), as has already been noted elsewhere.<sup>13</sup> Although the relationship of the initial B II structure to the large B I complex cannot be determined due to the lack of excavation records, it may be presumed that House B II was built up against the boundary of B I rather than vice versa. House B IV is more recent than the northern extension of House B II as it partly makes use of the latter's outer wall, or at least acknowledges its existence. — The façades of Houses B II and B IV (*Fig. 22*) correspond to this postulated construction sequence.

At a level of roughly 54 m there is an irregularity in the masonry of the southern façade of the sanitation tract of House B IV which corresponds to both the upper limit of the Phase 2 brickwork of House B II and the threshold level of the lowest doorway (53.97 m), subsequently blocked up. This plane would appear to indicate the street level of the period. Any renovation of

the house would have meant replacing those bricks most affected by water splashing off the street, i.e. knocking down the wall as far as street level and rebuilding it using the underground portion as a foundation.

It has frequently happened that the new wall did not exactly follow the course of the old, resulting in the indented overlapping already referred to (Rooms 5 and 6) or, as in Phase 3, in the slight misalignment of the façade towards the east. This can still be seen in the double joint in the south-west corner adjoining House B IV, which by then had obviously not yet attained its final form. The rebuilding of House B IV then produced the puzzling T-shaped irregularity still visible at the joint between the north-east corner of the sanitation tract and the south-west corner of House B II. The builders obviously intended both to make use of the existing substructure as the foundation for the new masonry and also to close the gap between the two houses, and the structural result was this awkward joint.

Also more recent than House B II is House B III, about which little more can be said due to the shallow excavation at this point. In a similar way the structural units B V<sub>1</sub>, B V<sub>2</sub> and B VI<sub>2</sub> then followed in sequence, although the position as regards B VI<sub>2</sub> is by no means clear due to an unexplained double wall.

To sum up then, the description of even such a coherent structural unit as House B II must necessarily appear generalized, yet this fact in itself underlines the need for further research. The available documentation and data on the Moneer Area have enabled us to lay the mere foundations of a proper investigation of this neglected site, which more than deserves all the scientific attention it will hopefully receive.

## Footnotes

- 1 M. Jansen 1984a: 139; 1984b
- 2 ARASI 1930-34: 51, 72; *ibid.* 1936-37: 41
- 3 ARASI 1930-34: 51
- 4 Jansen et al. 1984c: 54
- 5 Jansen 1984a: 141-143
- 6 This is equally true of the representatives of the ethnographically orientated "modern" or "behavioural" archaeology (Eggert 1978; Jansen 1984c: 39, note 1) and the younger of the "comparative" prehistorians (see the contributions in: Papenfuß, D./Strocka, V.M. 1982)

7 Neither could classification schemes such as those devised by Robert Koldewey, Walter Andrae or Ernst Heinrich (historical survey on research and bibliography in: Heinrich, E. 1982: 1) be applied (as, for example, in this case it is impossible to differentiate between the layouts of a so-called "Mittelsaalhaus", i.e. a house with a roofed-in central hall, and a "Hürdenhaus", i.e. a house with a central courtyard

8 Jansen 1984c: 39-41

9 Floorspace of a room in sqm, proportion EW/NS = relation of EW to NS extension of a room, prop absol. = absolute proportions of a room; quality I = room with opening to public space, II = transitroom, III = end room

10 Although the character of this court is questioned by the drawings of Wheeler, as obviously here some structures are discernable.

11 Sarcina 1978-79: Pl. V XII

12 *ibid.*: 169, Pl. XVI-XXXIX, i.e. 4 out of 42 "red" and 9 out of 58 "yellow types"

13 Jansen 1984a: 146

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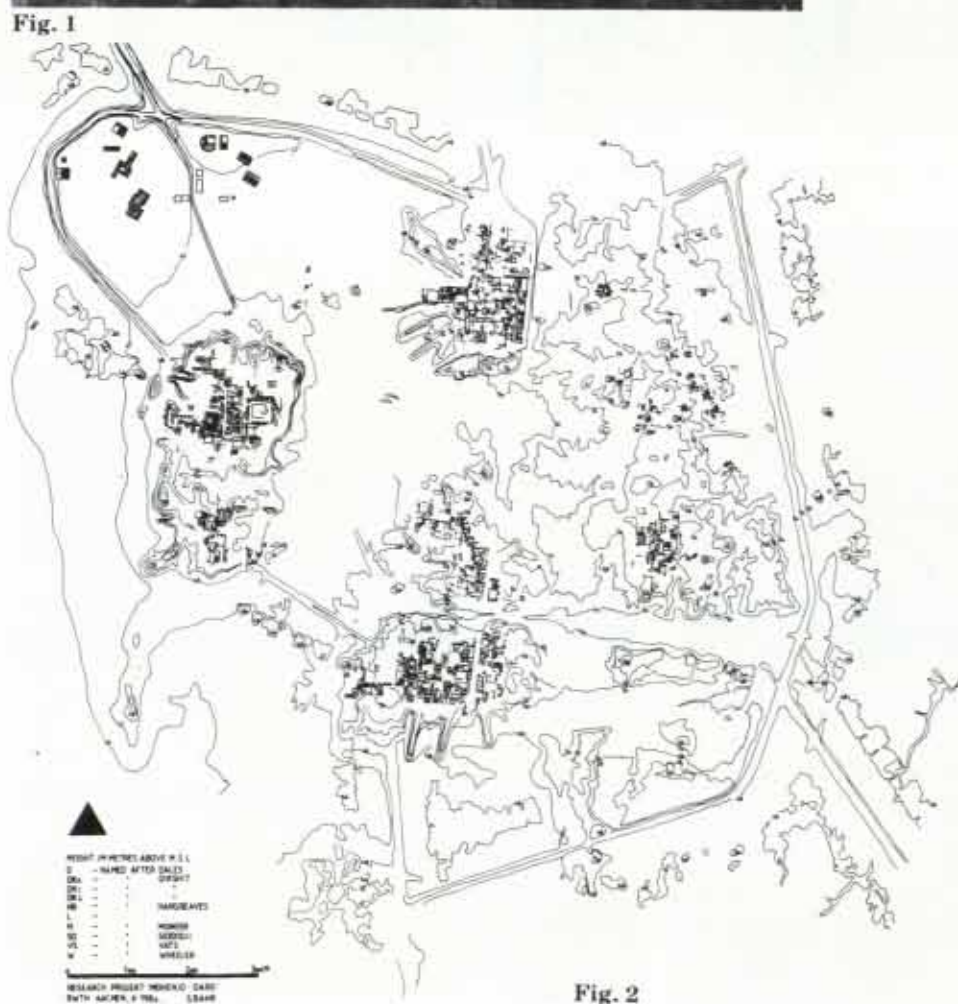
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**Fig. 1** Mohenjo-Daro, aerial view of Moneer Area.

**Fig. 2** Mohenjo-Daro, map of the site indicating the excavated areas.



**Fig. 2**



**Fig. 3** Mohenjo-Daro, excavation plan 1921-1982.

**Fig. 4** Mohenjo-Daro, trench DK-D east, later Moneer Area, as documented in Sind Volume IV 1924-25, 6568.

**Fig. 5** Mohenjo-Daro, trench DK-D east, later Moneer Area, as documented in Sind Volume IV 1924-25, 6567. Southern trench from north-east.

**Fig. 3**

**Fig. 4**



**Fig. 5**



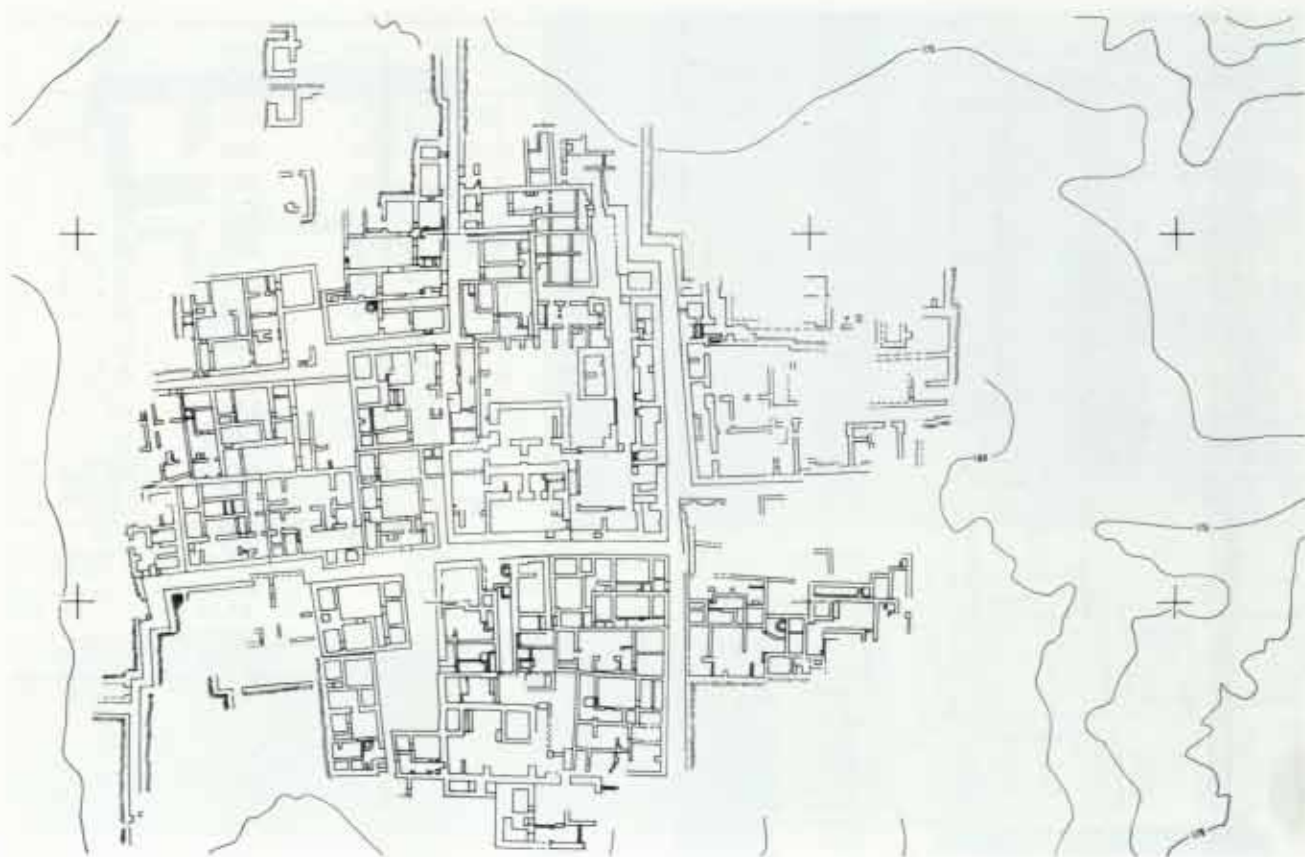


Fig. 6



Fig. 6 Mohenjo-Daro, Moneer Area (Wheeler 1950).

Fig. 7 Mohenjo-Daro, Moneer Area 1979/80.

Fig. 7

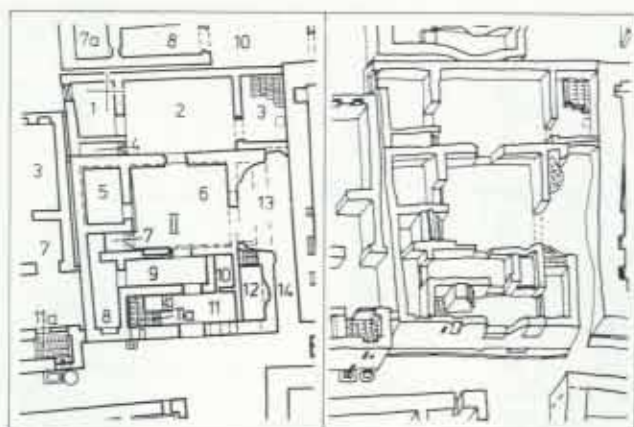


Fig. 8

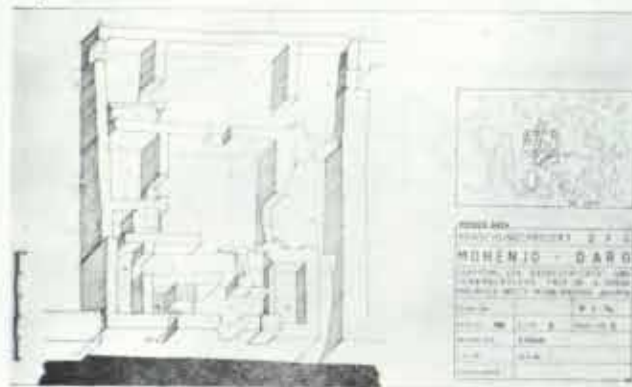


Fig. 9

Fig. 8 Mohenjo-Daro, Moneer Area 1985 (House B II)

Fig. 9 Mohenjo-Daro, Moneer Area House B II, isometrical view.

Fig. 10 Mohenjo-Daro, Moneer Area House B II, room space and proportions.

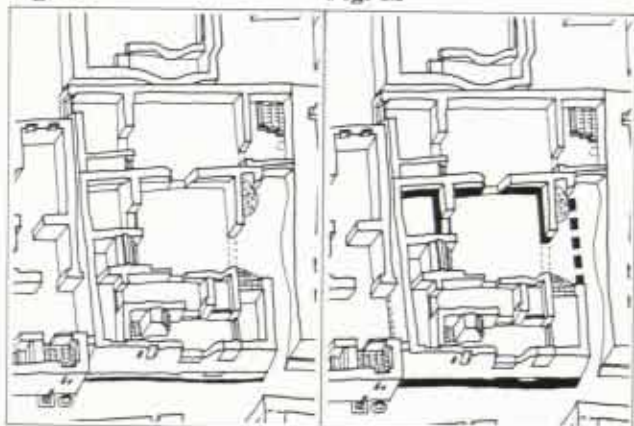
Fig. 11 Mohenjo-Daro, Moneer Area House B II, phase 1.

Fig. 12 Mohenjo-Daro, Moneer Area House II, phase 2.

Fig. 13 Mohenjo-Daro, house-types (Sarcina 1978/79: Pl. XII).

Fig. 11

Fig. 12



Room no.	space m <sup>2</sup>	prop. EW/NS	prop. absol.	quality
1	6.60	0.73	0.73	III (I)
2	23.20	1.45	0.69	II
3	7.92	0.61	0.61	III
4	1.33	2.71	0.37	III
5	6.00	0.67	0.67	III
6	22.44	1.16	0.86	II
7	0.86	0.86	0.86	III
8	4.84	0.40	0.40	II
9	6.02	3.07	0.33	II
10	1.46	0.51	0.51	II
11	9.12	3.56	0.28	I
12	3.36	0.43	0.43	III
13	4.20	0.24	0.24	I
14	10.80	0.13	0.13	I
total space			159.60	m <sup>2</sup>
effective space			107.19	m <sup>2</sup>
constructional space			51.44	m <sup>2</sup>
% of total space			32.23	%
proportion in relation to total space			0.32	

Fig. 10

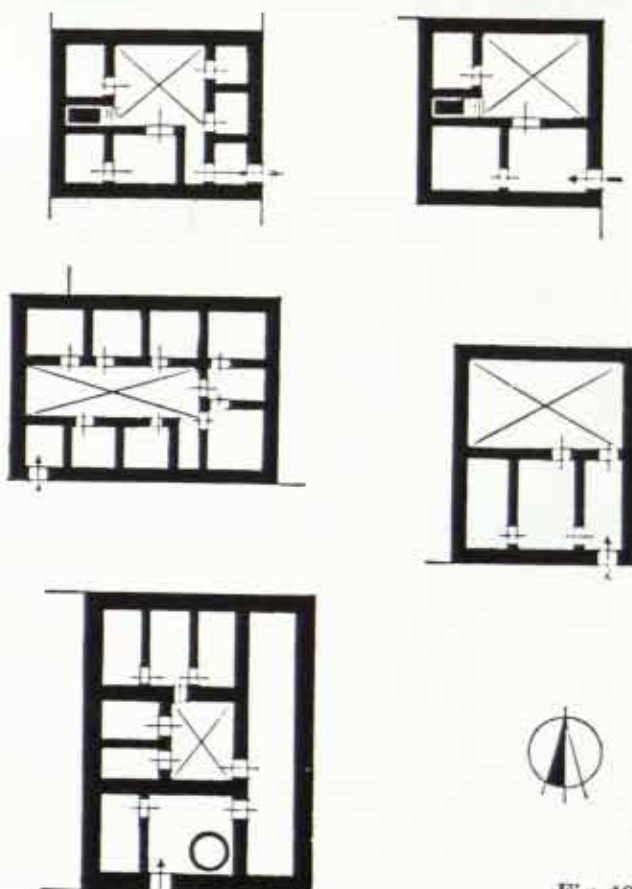


Fig. 13

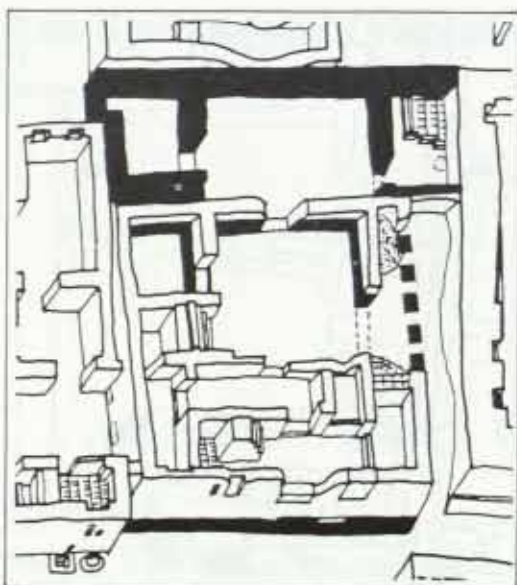


Fig. 14



Fig. 15

Fig. 17



Fig. 16

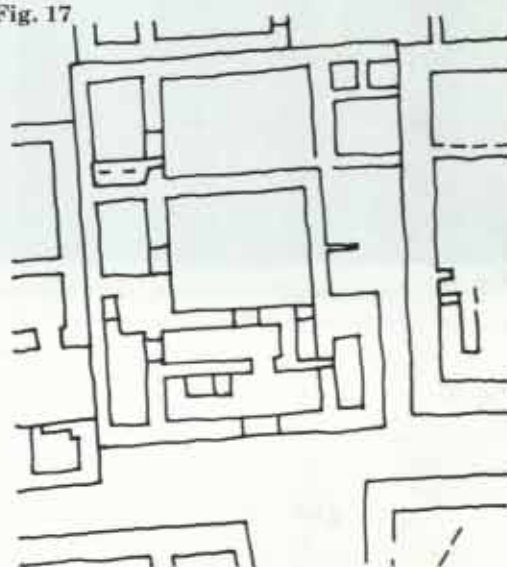


Fig. 18

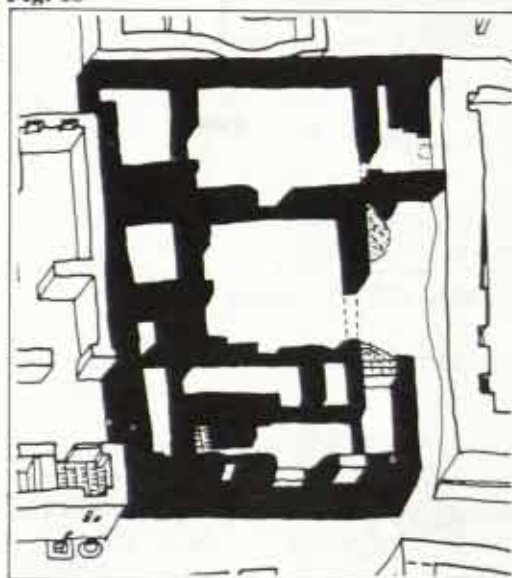


Fig. 14 Mohenjo-Daro, Moneer Area House B II, phase 3.

Fig. 15 Mohenjo-Daro, Moneer Area House B II, brick platform.

Fig. 16 Mohenjo-Daro, Moneer Area Street E-W-5 south of House VI, Room 11.

Fig. 17 Mohenjo-Daro, Moneer Area House B II (Wheeler 1950).

Fig. 18 Mohenjo-Daro, Moneer Area House B II, phase 4.



Fig. 19

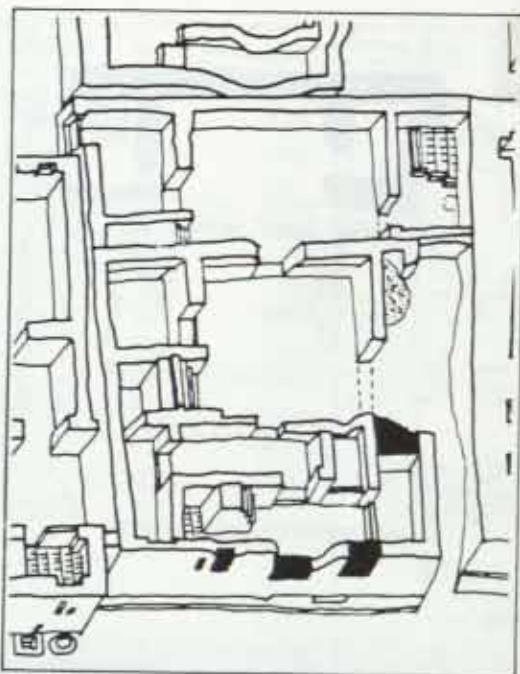


Fig. 20

Fig. 21

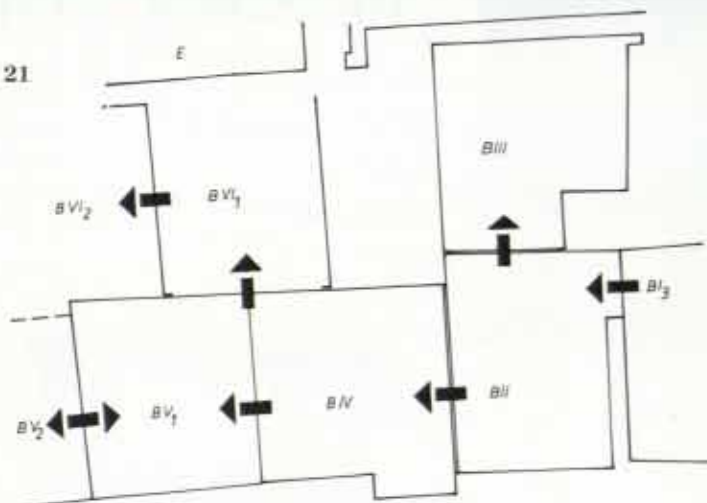


Fig. 22

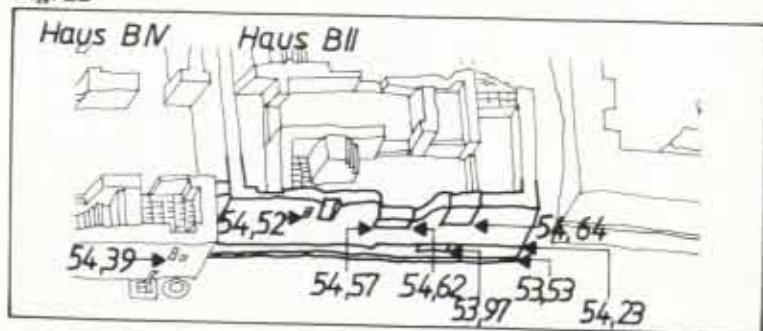


Fig. 19 Mohenjo-Daro, Moneer Area House B II, southern façade of Room 11a in Street E-W-5.

Fig. 20 Mohenjo-Daro, Moneer Area House B II, phase 5.

Fig. 21 Mohenjo-Daro, Moneer-B Area, direction of architectural expansion.

Fig. 22 Mohenjo-Daro, Moneer Area, façades of Houses B II and B IV.

# Axis Systems and Orientation at Mohenjo-Daro

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## 1. Introduction

The aim of the German Research Project "Mohenjo-Daro" was to conduct a thorough structural analysis of the city of Mohenjo-Daro, the emphasis not being restricted to architectural features only, but extending also to fundamental aspects of the construction of the town. These included the question of a planning concept behind the city layout: are there any definable routes through it and, if so, is there any relationship between them and the cardinal points of the compass?

Previous publications on the urban structure of Mohenjo-Daro showed a grid-like street pattern (Diez 1964: Fig. 1). Other authors such as Mumford (1963) saw in this pattern a precursor of Hippodamian town-planning (Piraeus) and the checkerboard layout of Roman towns. But it is doubtful whether such a grid reconstruction of the street system reflects the facts. Very few of the thoroughfares shown in the published plan are based on the evidence of excavations (solid lines), most of them are hypothetical reconstructions (broken lines). Even where topographical features would appear to indicate the continuation of certain axes, there is no factual justification for linking up street sections to form long straight thoroughfares. Furthermore the plan is based on the tacit understanding that the entire site was settled at the same time. Therefore it seems pertinent to investigate the layout and orientation of the street axes of Mohenjo-Daro in more detail.

A possible layout reconstruction shall be considered under astronomical aspects and an attempt made to answer the question whether artificial or natural landmarks in connection with the rising and setting of certain celestial bodies may have been used as a calendar.

E. Macla (1984) partly based his astronomical explanation model for the ringstones as calendar stones on the observation that the alluvial plane of the Indus lacked a physical basis for a natural calendar.<sup>1</sup> However, this statement is not altogether true, at least not for some hours of the day.

## 2. Axis Systems at Mohenjo-Daro

Regarding the examination of the axis systems, the topographical maps published so far are not sufficiently reliable because the various excavated areas were not surveyed according to a uniform system of coordinates and the geodetic origin of the indicated cardinal points is not given.

It was only during the 1979/80 field season that more precise preparations for such an examination could be made:

- a triangulation net of fixed points was marked out over the entire site covering all the excavated areas;
- the coordinate axes were carefully orientated according to astronomical calculations.

This grid served as the basis for a new survey of the excavated areas to the scale of 1:200 and for a general topographical plan drafted from aerial photographs to the scale of 1:1000.

Generally speaking, the word "axis" in an urban context refers to the connecting line between two points of an architectural unit such as a façade, borders of a street, a canal or also the interior access system of a house.

The following scheme is limited to:

- general access axes in the excavated areas;
- strikingly long topographical depressions which may indicate buried streets.

### Axes in the Excavated Areas

Area	Axis	Deviation <sup>2</sup>
DK-G South	First Street	7.2
	Central Street	4.5
DK-A	Drain	5.5
DK-G North	West Street	5.2
VS-A	First Street	10.2
	Lane One	10.3
	Lane Two	9.5
HR	First Street	8.3
	Third Street	3.9
	Southern Part	
SD	Main Street	4.4
	Granary	5.5
	Great Bath West	5.3
	Divinity Street	5.8
	Stupa	5.5
DK-B/C	North-South Street	+ 5.8
Moneer	NS 5	- 0.4
	NS 6	- 0.1

### Topographical Axes

Area	No.	Length	Deviation (gon)
E of Moneer	1	300 m	9.0
W of Moneer	2	500 m	9.6
First Street HR and VS	3	560 m	11.0
Street axis in Dales	4	240 m	10.1
E-W depression	5	1000 m	9.8
N-S depression between VS and Moneer	6	250 m	0.1
N-S 5 axis in Moneer	7	400 m	0.3

Due to the uncertainty of the natural axes and the error margin of opisometrical readings there is a possible divergence of  $\pm 1^{\text{gon}}$ .

If we transfer these axes onto the topographical map we find the following structures (Fig. 11):

- the axes of the main access routes in the areas SD, L, HR, VS, Dales, DK-B+G show a divergence of  $7-10^{\text{gon}}$  towards East (Fig. 14);
- the topographical axes 6 and 7 and the Moneer and DK-C axes are orientated exactly towards the cardinal points;
- the North-South axis in the Moneer area continues southwards through the East-West depression (Fig. 13);
- the street axis DK-B continues right through to the east of the HR-area;
- the street axis of the Dales area is clearly discernible through brickwork that emerges on the surface 300 m south of it (Fig. 16);
- the topographical axes which run parallel to the HR street axis to the east and west of it are about 190 m apart from one another.

Thus we can define two different axis systems in Mohenjo-Daro:

system 1 is characterized by a noticeable shift in orientation of ca.  $8^{\text{gon}}$  clockwise, rectangular crossings of the axes and partly identical distances between the latter. System 2 is characterized by an exact orientation to the cardinal points but does not occur as often as system 1.

The ability to draw a right angle which is obvious in the system of axes and many of the ground plans of the houses is not apparent to the Great Bath (Fig. 2).

For the divergence of system 1 from the cardinal points several possible explanations can be considered:

- no great importance was attached to the exact orientation of the axes but whatever orientation happened to be chosen initially it was subsequently followed;
- the orientation had some relevance, but it was technically impossible to take more exact measurements. It cannot be reconstructed which orientation techniques were used;<sup>3</sup>
- in 2000 B.C. the star nearest the North Pole, the North Star, was Thuban of the Draco constellation.

Its distance from the celestial pole measured — depending on the period — 1 to  $3^{\text{gon}}$ . Consequently it is possible that an orientation towards this star was the cause of the divergence noted;

- the axes were orientated via an East-West line towards the rising or setting points of a star or a planet. A fixed star would be more probable because it does not change its point of setting over long periods;
- the divergence is due to unknown religious or mythological reasons.

### 3. Axis Systems at other Sites

This orientation of architectural axes to the cardinal points with slight divergences is not only observable in Mohenjo-Daro, other settlements of the Harappan culture also show similar orientation patterns.

Site	Axis	Divergence from North in gon
Harappa	Citadel	0
	Streets	- 11 to + 6
Surkotada	Town wall	- 16
Lothal	"Dock" wall	+ 5,5
	Street 1	- 4,4
Suktagen Dor	Surrounding wall	- 2
Balakot	West Lane	+ 3,3
	East Lane	- 1
Kalibangan 2	Surrounding wall E	0
	Exterior wall W	- 2
	Main Street	- 13

The orientation readings were taken from Jansen 1979.

All the settlements taken into account tend to show the same pattern: an approximate general orientation of important axes towards the cardinal points with slight divergences of several gon.

We cannot make statements regarding the orientations of other sites from the data available, as their definition of North and the degree of precision reached in calculating it is unknown. Especially the use of magnetic compasses and the failure to allow for declination could lead to major mistakes.

#### 4. The Horizon Calendar

If the orientation of architectural axes in Mohenjo-Daro really does have an intrinsic meaning and function, it would be most likely that of a calendar. We know from other contemporary cultures that their buildings were designed with a parallel use as calendars in mind. The rising and setting of celestial bodies in line with certain axes served as fixed points of the year (as, for example, in the case of the Egyptian pyramids, Stonehenge, Carnac). Sometimes artificial axes (rows of standing stones) were combined with natural landmarks on the horizon (Krupp 1980).

At first glance it seems improbable that the alluvial flood plain of the Indus river could yield any natural landmarks in the region around Mohenjo-Daro. In addition, visibility is limited to a few kilometers during the day due to the dusty haze.

But one hour before daybreak the impressive profile of the Kirthar range 100 km away appears clearly on the horizon. The peaks and valleys of this silhouette offer excellent fixed points which allow the points of setting of celestial bodies to be assimilated with a horizon calendar.

In order to examine the possible function of the Western horizon as a calendar, the azimuths of prominent points of this mountain profile were measured and a photographic recording sequence of the horizon was made, during the 1980/81 field season.

##### 4.1. Periodic Changes in Astronomical Phenomena

Today's astronomical constellations cannot be taken as the basis for an investigation into the possible calendar function of the horizon in antiquity.

Visibility, rising and setting points of the stars are subject to constant change. The astronomical data of the planets and the moon change most rapidly. Their historical positions can only be reconstructed for a precise point in time, not for a period. As the complete period from 2500 up to 1500 B.C. is relevant for our investigation, only the effects of the periodic change in astronomical data of the sun and fixed stars will be taken into account.

This change is determined by the following factors:

- rotation of the Earth = movement around its own axis
- revolution of the Earth = movement around the Sun
- precession = movement of the rotation axis of the Earth on the envelope of a cone
- change of obliquity of the ecliptic

##### Rotation and Revolution

The movement of the Earth around the Sun together with its own rotation causes the non-circumpolar<sup>1</sup> constellations to shift their points of rising and setting in the course of a year.

Consequently some of them are not visible for part of the year, as they then rise and set during the day. Thus we are familiar with typical seasonal constellations like Orion in winter and Sagittarius in summer.

The reason for these phenomena is that at a certain time of the year the Earth is situated between the Sun and the constellation (which is visible at night), whereas half a year later the Sun stands between the constellation and the Earth and the star would be visible only in daytime.

On its orbit around the Sun the equator of the Earth is inclined against its orbital plane; today the obliquity of the ecliptic measures  $23.44^\circ$ . Visible consequence of this obliquity on Earth is the seasonal<sup>5</sup> change of the zenith of the Sun, the varying length of the days and the shifting points of sunset and sunrise.

The angles ( $d$ ) between the setting points at the solstices depend on the geographical latitude; they are only minimal at the equator with the double obliquity of the Earth ( $d=47^\circ$ ) and not definable in regions north of the Arctic Circle, where the Sun does not rise in winter nor set in summer.

Rising and setting of the fixed stars are not influenced by the obliquity of the ecliptic. Each of the non-circumpolar stars always touches the horizon at the same point.

##### Precession

The dynamics of the Earth closely resemble a child's spinning top. The effect of the gravitation of the Sun is that certain forces strive to raise up the oblique axis of the earth into a right angle. Just like a top, which is spun from outside and starts to wobble, the pole axis forms an envelope of a cone and the celestial pole forms a circle. The period of precession, i.e. the time of one orbit describing the cone envelope, amounts to 25.800 years.

The movements in the Earth-Sun- and Moon system are hardly influenced by precession, but the course and the visibility of the fixed stars are very much affected.

## Sun

While the Sun's visibility and her points of rising and setting are constant the beginning of the seasons shifts in accordance with the position of the Earth on its orbit around the Sun.

Nowadays the summer solstice occurs 10 days after the Earth has passed through its orbital point most distant from the Sun (Aphel). But 13.000 years ago the Earth passed through its orbital point closest to the Sun (Perihel) at the beginning of summer.

As greater proximity to the Sun implies a higher degree of energy radiation, the climatic seasonal extremes — discounting other factors — would have been much more intense 13.000 years ago.

## Fixed Stars

Precession largely determines the visibility of fixed stars. The extension of the rotation axis of the Earth into the celestial sphere, i.e. the celestial North Pole, describes a circle with a diameter of  $47^\circ$  in 26.000 years.

Thereby various stars approach the North Pole in turn and consequently become the North Star of the respective epoch. Today the brightest star from the Ursus Minor constellation is very close to the Pole; in 2500 B.C. its place was taken by the somewhat less bright star Thuban from the Draco constellation and in 11.000 B.C. by the bright star Wega from the Lyra constellation.

As a result of precession, circumpolar constellations shift gradually in relation to a fixed point. Stars become visible which otherwise remain below the horizon. The Southern Cross, today only visible from the southern hemisphere and in subtropical northern latitudes rose as far north as  $50^\circ$  latitude 10.000 years ago.

Precession changes the points of rising and setting of fixed stars on the horizon. The degree of shift is not constant and depends on the starting position of the relevant star.

## Azimuth of Setting Points

	2000 A.D. Declination (gon)	of star	2500 B.C. Declination (gon)	of star
Procyon	307,0	$5,2^\circ$	306,1	$4,5^\circ$
Andromeda	337,5	$29,1^\circ$	309,8	$7,5^\circ$
Cassiopeia	379,1	$56,5^\circ$	342,9	$33,2^\circ$

Extensive tables with the historical positions of the stars are to be found in *Baehr*.

## Shift in Ecliptic Obliquity

The angle formed by the rotation axis of the Earth with the path of its orbit around the Sun (obliquity of the ecliptic) changes slowly in the course of the centuries, reducing by  $0,1^\circ$  in 1000 years. Thus the precession of the celestial pole is actually not a closed circle but a spiral. The consequences of the changing obliquity of the ecliptic for the points of rising and setting of the fixed stars are minimal compared to the effects of precession.

Over longer periods of time, this changing angle has a noticeable effect on the points of sunset and sunrise at the solstices — they shift to the west.

In relation to the geographical position of Mohenjo-Daro, the setting point at the solstices shifted, due to the obliquity of the ecliptic, by  $0,6^\circ$  between 2500 B.C. and 2000 A.D.. This equals the apparent diameter of the Sun disc.

Finally it should be mentioned that atmospherical conditions also have a major influence on the visibility of celestial bodies. Close to the horizon a beam of light travels a longer distance through denser layers of air as it does close to the zenith.

This causes:

— REFRACTION, an apparent higher position of the star, as the beam of light is curved. While it has already set astronomically, its image is still visible above the horizon. (Fig. 8)

— EXTINCTION, the absorption of the energy radiation i.e. reduced brightness. The star is extinguished when it comes close to the horizon. At an altitude of  $10^\circ$  above the horizon the starlight is weaker by one magnitude ( $1^m$ ), at  $1^\circ$  by  $4^m$ .

As the eye is able to recognize stars down to a brightness of  $5^m$  to  $6^m$ , only the rising and setting of very bright stars (magnitude  $\leq 1^m$ ) is visible on the horizon.

For the sake of completeness it should be mentioned that yet other effects may alter the apparent movement of the stars, such as nutation, aberration, parallax and their own motion. But this applies only on such a minimal scale that it has no influence on the following reconstruction.

#### 4.2 Astronomic Reconstruction of the Course of Stars on the Western Horizon for the Period 2500—1500 B.C.

It may be concluded from the shifting astronomical parameters outlined in the preceding chapter that the changing obliquity of the ecliptic has a marked effect on the course of the Sun, whereas the course of the fixed stars is influenced by precession.<sup>6</sup>

##### Sun

The obliquity of the ecliptic in 2500 B.C. measured  $23.98^\circ$ , in 1500 B.C.  $23.86^\circ$  and today it measures  $23.44^\circ$ . The refraction taken into account the apparent course of the Sun at the solstices and the equinoxes is shown on the photograph of the horizon profile (Fig. 9). The point of setting at the winter solstice is remarkable; here the Sun disappears down a deep valley in the south-west, having taken its course along a steep slope. Fig. 15 shows the sunset on the 22<sup>nd</sup> of December 1982, to the left of it we see the course of the Sun at the winter solstice in 2500 B.C.

On the topographical map 1:500,000 (Fig. 10), the identification of these two valleys shows the following situation:

the most southern valley belongs to a mountain saddle, whereas the deep valley west of it is in fact the river gorge of the Gaij-Naij river crossing the Kirthar range. In 1938 settlements were discovered somewhat further to the east, which belong to the early Harappan period (Deva; McCown 1949).

This valley can be regarded as the starting point for a natural horizon calendar using the sunset as indicator. The strongly undulating mountain silhouette offers many orientation marks in the course of a year: a shallow depression at the equinoxes and yet another one at the summer solstice.

##### Fixed Stars

As was mentioned in Chapter 2, the architectural axes of Mohenjo-Daro show a slight divergence from the cardinal points of  $1^\circ$  to  $2^\circ$  clockwise.

This could be explained by the fact that they were orientated towards the setting point of a star. As the starlight close to the horizon is subject to extinction, it must have been a very bright star which set close to cardinal west. For the period under consideration (from 1500 to 2500 B.C.) there are only two fixed stars which meet these conditions:

Name	Constellation	Brightness	Setting Point from W to N (gon)	
			— 2500	— 1500
Procyon	Canis Minor	0. <sup>m</sup> 5	+ 5.4	+ 8.3
Aldebaran	Arietis	1. <sup>m</sup> 1	— 3.0	+ 3.8
	Pleiades	3. <sup>m</sup> 0	+ 2.4	+ 8.0

In Fig. 9 the courses of the three stars during the different centuries are indicated. The setting point of the star Aldebaran coincides with the divergence of Mohenjo-Daro's street axes for the period from 2000 to 1600 B.C.. At the same time the axis of the "Granary" pointed towards the setting point of Procyon.

Due to the reduced brightness, the setting of the Pleiades cannot be observed on the horizon. The Arabic astronomers called Aldebaran "*he who follows the Pleiades*". The Pleiades, the Seven Sisters, are the celestial manifestation of the mythical number seven.

Before all the facts given so far are accounted for in a reconstruction model, the essential observations can be summarized again briefly:

1. In Mohenjo-Daro, but also in other sites of the Harappan culture, a slight divergence of the architectural axes from the cardinal points can be detected.
2. The characteristics of the Kirthar range profile furnish the topographical preconditions for a horizon calendar.
3. Close to the mountain valley where the sun sets at the winter solstices, early Harappan settlements have been found.
4. In 2000 B.C., two very bright stars which could still be observed on the horizon set north of cardinal west. The street axes of Mohenjo-Daro are orientated towards the same direction.

These observations suggest the following theory: the site upon which Mohenjo-Daro was founded was selected because of its position on the Indus and the direction of the early Harappan settlement in the valley towards the rising point at the summer solstice. The horizon outline of the Kirthar range provided the conditions for establishing a natural calendar starting at the point of the winter solstice in the valley of their predecessors. The special importance of the number seven and its celestial manifestation may have influenced the orientation of the axes towards the Pleiades and the star Aldebaran, whose setting point could be observed on the horizon.

A consequence of such a reconstruction would be that the orientation of the architecture shifted in the course of the centuries; the system of orientation is also a dating system. In order to verify this theory, exact astronomical orientations would have to be calculated at other sites of the Harappan culture.

## Footnotes

- 1 "In Moenjo-daro, however the horizon is not broken by natural landmarks rising from the alluvial plane" (Maula, E. 1984: 161).
- 2 Deviation here means the relative orientation towards any of the cardinal points with a clockwise divergence, for example: 3.5 = North with a divergence of 3.5° towards East.
- 3 From other cultures the use of the so called Gnomon is known (i.e. a stick that casts a shadow). If cardinal North is not derived from the shortest length of the shadow but from the bisector of angles from corresponding shadow lengths both in the morning and in the afternoon, there is a high degree of exactness.
- 4 Circumpolar are those constellations which do not set below the horizon line. Circumpolarity is dependent on the geographical latitude; at the poles every constellation is circumpolar, at the equator none.
- 5 "Seasons" in this case is used in its normal sense. Obviously in Mohenjo-Daro the climatic-seasonal division of the year is different, see Jansen 1979: 60.
- 6 The courses of the planets are not reconstructed in this paper. Their reconstruction is theoretically possible (Ahnert 1961), but only for given dates due to their orbiting speed. With the courses of the planets coinciding with the plane of the Sun orbit (Venus 3.5°, Mars 2°, Jupiter 1°), they always set near the cardinal west, but this changes in the course of time.

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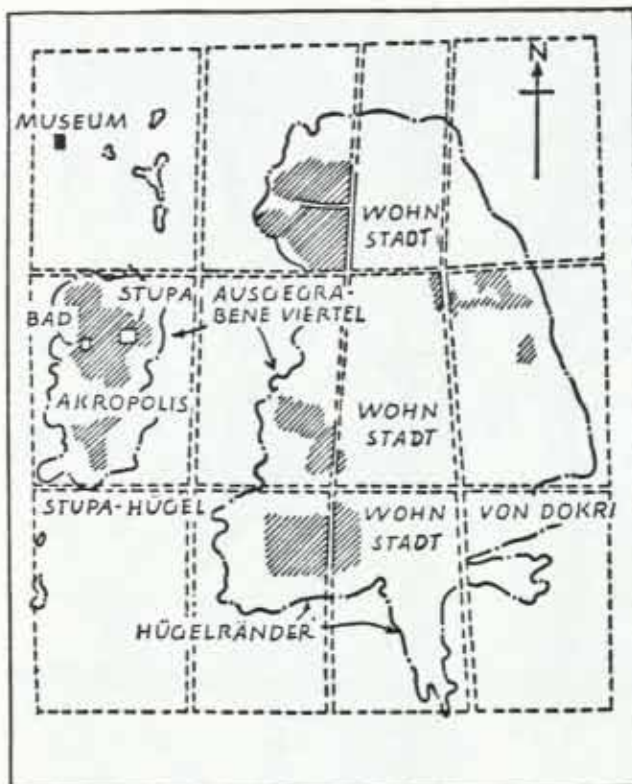


Fig. 1

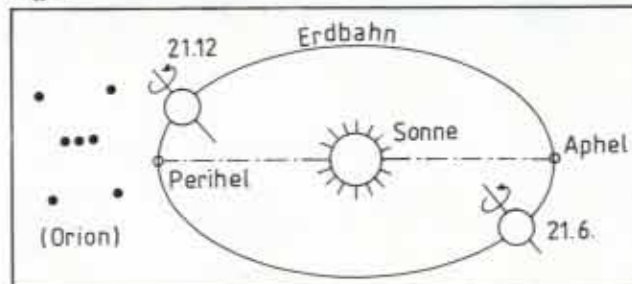


Fig. 3

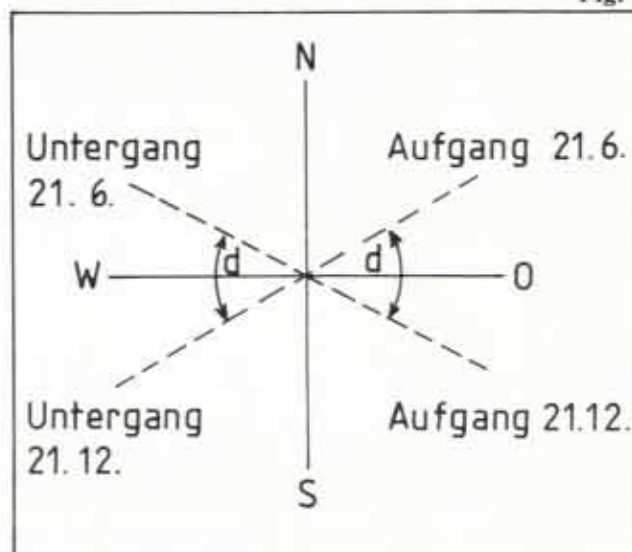


Fig. 4

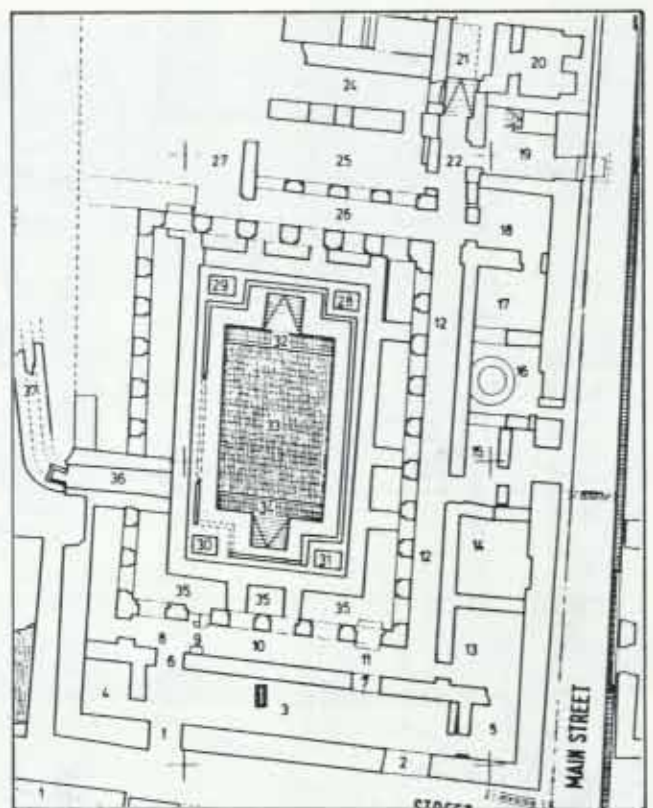


Fig. 2

Himmelsnordpol  
z. Zeit  $\propto$  Ursae minor

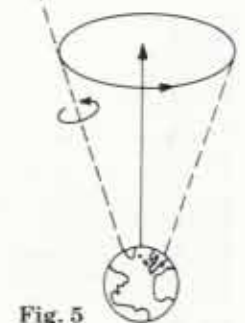


Fig. 5

Fig. 1 Hypothetical Street Pattern of Mohenjo-Daro (after Wheeler 1968)

Fig. 2 Mohenjo-Daro, Great Bath

Fig. 3 Periodic Visibility of Orion due to the Rotation of the Earth

Fig. 4 Difference between the Points of Rising and Setting of Fixed Stars at Summer and Winter Solstices (Angle "d")

Fig. 5 Precession of the Earth

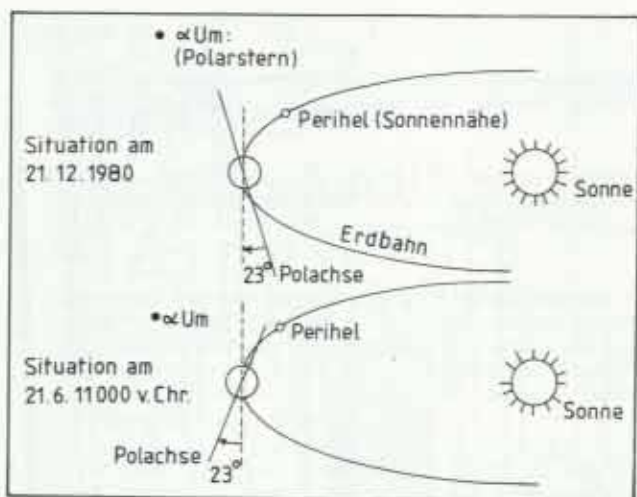


Fig. 6

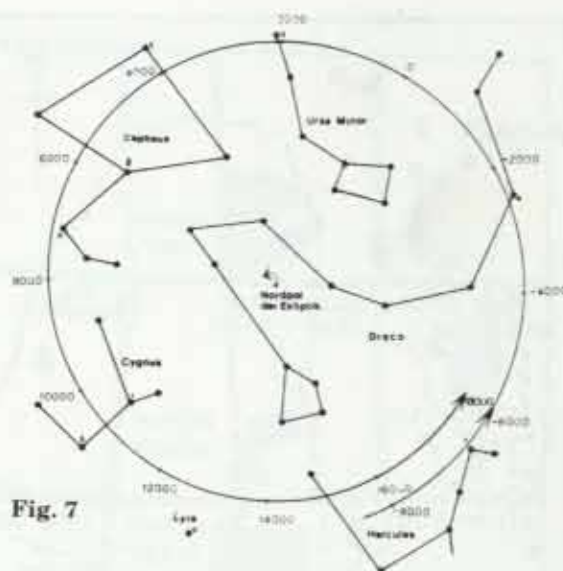


Fig. 7

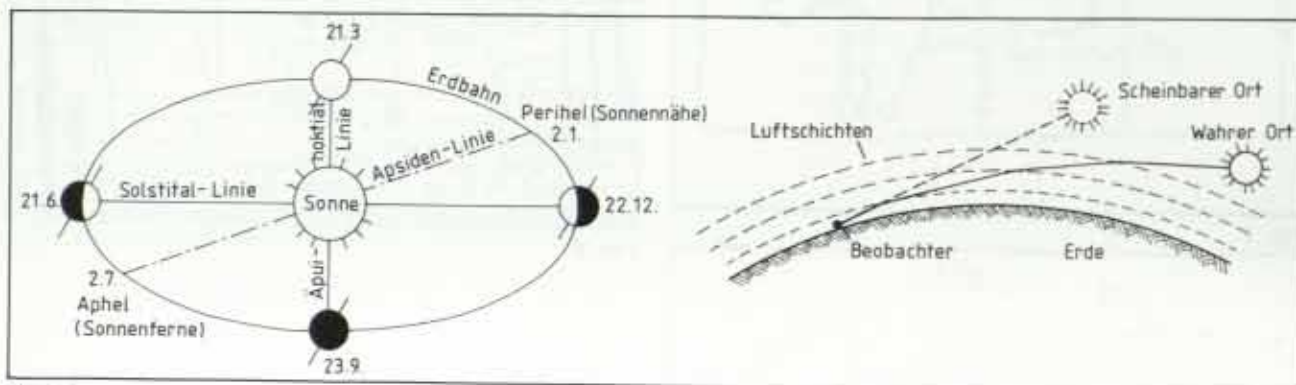


Fig. 8

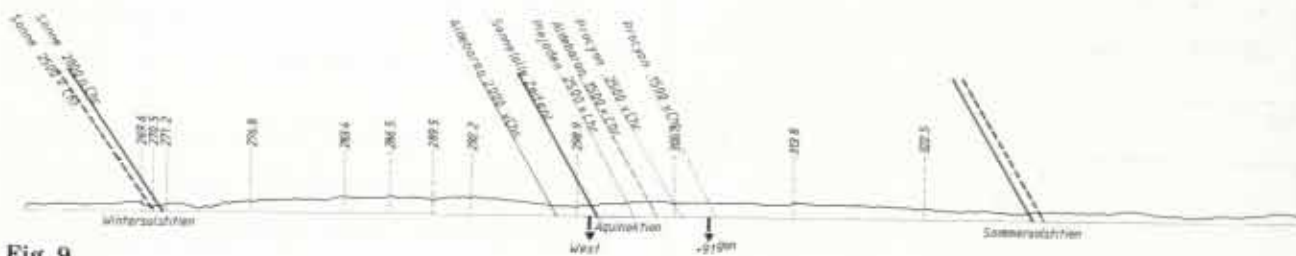


Fig. 9

Fig. 6 Change in the Visibility of Fixed Stars (Polestar) due to Precession

Fig. 7 Rotation axis of the Earth projected onto the celestial sphere (after Petri 1978)

Fig. 8 Example of Refraction of the Sun

Fig. 9 Setting Points of Fixed Stars on the Kirithar Range Profile at different Epochs

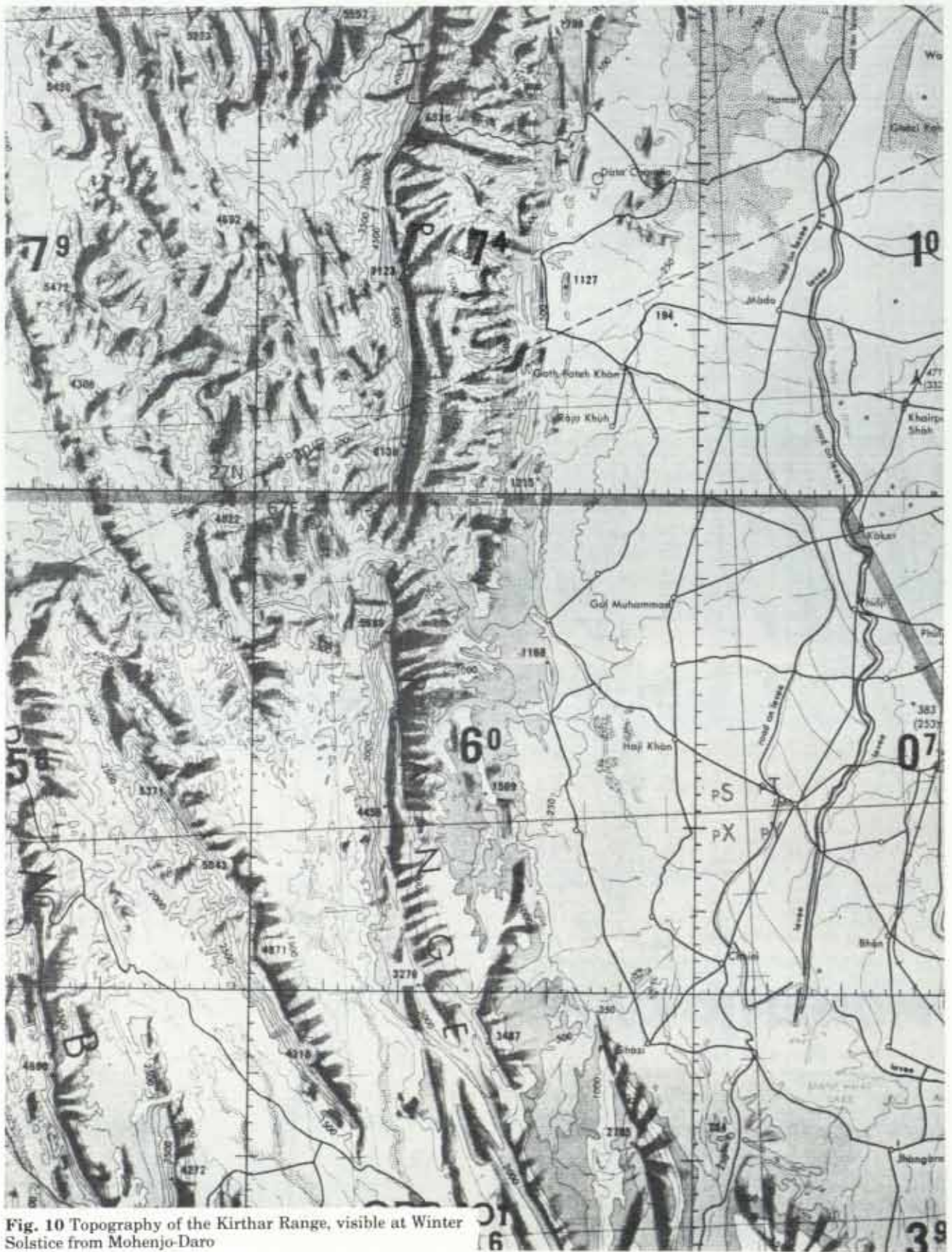
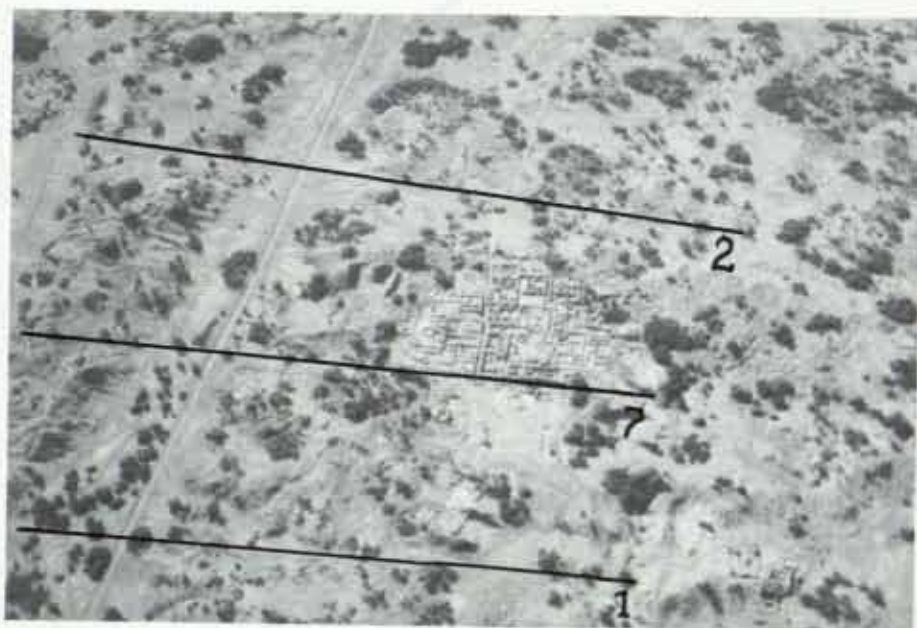


Fig. 10 Topography of the Kirthar Range, visible at Winter Solstice from Mohenjo-Daro



Fig. 11 Topographical Map of Mohenjo-Daro with General Access Axes (1-7)





**Fig. 13** Axes 1, 7, 2 in DK-A, MN and DK-B

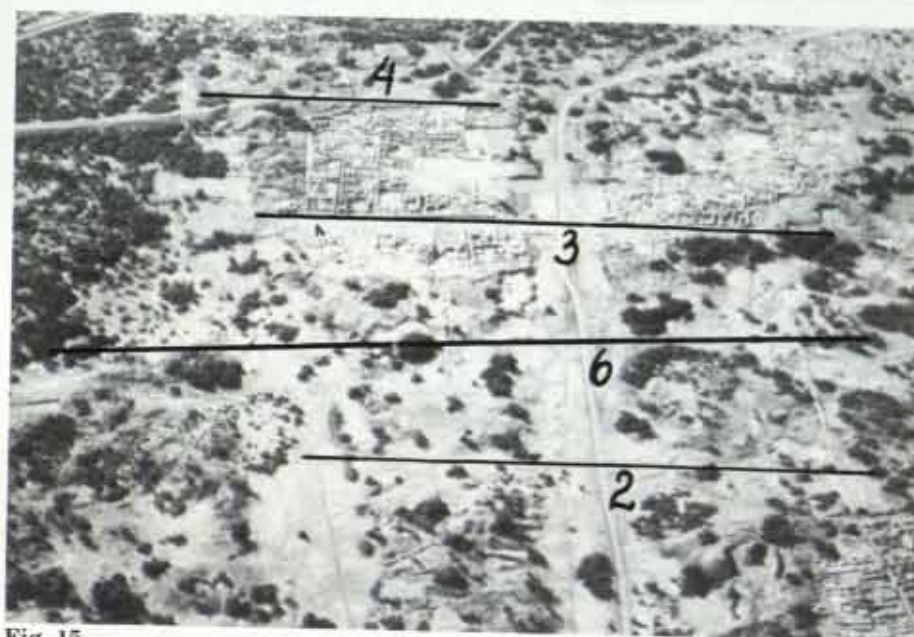
**Fig. 14** Axes 2, 6, 3, 4 in DK-B, between DK-B and VS, VS, HR, and DK-G

**Fig. 15** Points of Sunset at Winter Solstice in 2500 B.C. and in 1980 A. D.

**Fig. 16** Street Axis in Southern Dales Area

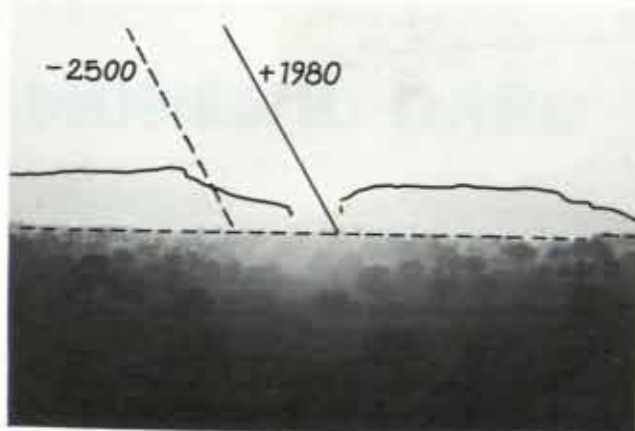
**Fig. 13**

**Fig. 14**



**Fig. 15**

**Fig. 16**



## Preliminary Report on the Stūpa and the Monastery of Mohenjo-Daro<sup>1</sup>

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Henry Cousens' *Antiquities of Sind* was published (with delay, that is true) in 1929. The book contains the reports on the surveys carried out between the end of the 19th century and the second decade of the 20th century, which had already appeared in the *Archaeological Survey of India Annual Reports (ASIAR)* and in the *Progress Reports of the Archaeological Survey of India Western Circle*. The volume deals with the historical antiquities of Sind, especially Buddhist and Islamic ones. This fact is all the more striking as, N. G. Majumdar's *Explorations in Sind*, published in 1934, deals almost exclusively with the proto-historical antiquities of the region. A few years were enough to shift scientific and antiquarian interest radically in a new, unsuspected direction, which is still being pursued with success at present.

When, with the excavation campaign of 1921-22, Rakal Das Banerji began to dig at Mohenjo-Daro, he was certain that it was a historical site, and since the ruins did not look Islamic, they had to be almost certainly Buddhist. The known facts (Harappa's excavations had barely begun the year before) did not allow room for doubt. Buddhist archaeology had been known to be very promising in North-Western India since the time of Cunningham, who had provided the first plans and information on Taxila, Takht-i Bāhi, Jamāl Garhi, etc. in his *Archaeological Survey of India Reports (ASIAR)*. More recently, D. B. Spooner and H. Hargreaves had excavated successfully at Shāh-jī-kī Dherī (Spooner 1908-9; Hargreaves 1910-1). John Marshall had been excavating at Taxila since 1913. Beyond the Khyber, A. Foucher was about to begin the Afghan chapter of North-Western archaeology after his spectacular, even questionable, expeditions had revealed the Buddhist antiquities of Chinese Turkestan. Sind, as Cousens had partly shown, might promise the discovery of equally prestigious Buddhist sites. Buddhism had been chosen by Western scholars

as a presumed weak spot in Indian civilization on which to work, so as to be able to present an ideal, no longer contestable, model for the whole of India. It was distorted to represent European rationalism in Asia, being free — or so it seemed — from practices that were judged unacceptable, and having moreover acquired in Western eyes the merit of being a "progressive" historical movement. A. K. Coomaraswamy and Giuseppe Tucci, in different ways, were to oppose these interpretations.

All this must be taken into account to understand Banerji's position, even without intending to absolve him from his limited but by no means negligible responsibilities. Mohenjo-Daro appeared to him as a cluster of five shrines<sup>2</sup> built "on a group of five islands" floating on dust. Two of these "shrines" were excavated. The first, indicated by Banerji as Site No. 1, corresponds to the present Stupa Area, and forms the part of the excavation dealt with here. The "second shrine, on the larger island", only partly unearthed, is also in sector SD, to the north-west of the first, and thus to the north of the "Great Bath". Banerji's excavation report has remained unpublished, and on these initial excavations at Mohenjo-Daro we have only the meagre information from Banerji reported in *ASIAR*, 1922-23.

### Site No. 1

According to this report the results of the excavation can be summarized as follows. On a rectangular terrace of backed bricks ("a high artificial tower") there is "a quadrangle consisting of series of chambers on all four sides enclosing a courtyard with a stupa in its centre" (Banerji 1922-3; see here Fig. 1). Its drum, made of unbaked bricks, rose on "a stepped platform" which presented "a small porch on its eastern side", leading "to a small passage" from which two flights of stairs led off (cf. Figs. 5, 6), intended perhaps "for the use of pilgrims who wanted to go up to the base of the stupa" (*ibid.*). At the end of the passage (shown by No. 65 in the plan given by Marshall; see Fig. 1; cf. Fig. 5) was a niche, "which once contained a seated image of Buddha, made of clay, but with a core of burnt bricks" (*ibid.*). The stupa had been excavated by treasure-seekers<sup>2</sup>, who left among the debris the presumed "reliccasket of white marble and its lid of polished conch-shell" (*ibid.*: 103). The sides of the drum were "covered with fresco-paintings" on which fragments of an inscription were preserved, similar to those "discovered by Sir Aurel Stein in Khotan" (*ibid.*: 102-3).

The rooms around the *pradakṣiṇāpatha* turned out to belong to four different periods (cf. Fig. 1). Coins of

Vāsudeva I, of the Siva and Bull type, were associated with the top layer; with the third layer "thick oblong copper coins" resembling "the indigenous issues of the ancient city of Taxila" and — in Room 3 — "numerous fragments of images of stucco, turned into porcelain by the action of intense heat", among which was found "the bearded head of a barbarian wearing a pointed cap, similar to the figure discovered in one of the monuments at Taxila" (*ibid.*: 103). At least "four thick oblong copper coins inscribed with pictograms" were associated with the lowest level. Moreover, "the walls of the earliest period and a pavement were found below the level of the ashes over which the platform of the stupa was built" (*ibid.*).

Two other trustworthy pieces of information given by Banerji, are worth recording. The first is that the sides of the "stepped" platform of the stupa "were covered with ashes, proving that the shrine was destroyed by fire"; the second, disconcerting is that "the entire area of site No. 1 was covered with funeral urns of various size and shapes. The majority of them are pointed at the bottom but some of the large jars are round. These contained smaller but pointed funeral urns and miniature necropolitan pottery" (*ibid.*: 102, 103). It thus seems that the Buddhist area was covered by material belonging to the proto-historical town.

### The Stūpa

The publication of the Stūpa Area is owed to J. Marshall, who included it in his *Mohenjo-Daro and the Indus Civilization* (1931). Marshall, then Director General of the Archaeological Survey of India, immediately assumed the direction of the excavations at Mohenjo-Daro as soon as it was realized what the site involved. In his report Marshall declares explicitly more than once that he is not in agreement with Banerji's conclusions — but the excavation of the Stūpa Area was by now completed, and for publication he could do nothing but rely on Banerji's *Report*, which had been submitted to him (*cf. Majumdar 1931: 128*) and was left unpublished because of him. It was only in 1924, however, that Marshall could see "the collection of antiquities" recovered by Banerji (*Marshall 1923-4: 48*) — a delay that had serious consequences as far as we are concerned, since in the meantime fragments of crucial importance had disappeared — or so it seems (*see infra*).

The whole complex formed by the stūpa and monastery — according to Marshall (1931: 113) — "was many times repaired or rebuilt".

The plinth of the stupa (Banerji's "platform"), which "sprang from a little lower level than the earliest of the pavements" of the courtyard, was covered later

on by three successive retaining walls (*cf. Fig. 1*), to which the different floors brought to light in the courtyard refer. The projection clearly visible along the body of the plinth (*Figs. 7, 8*) would immediately suggest the level of one of these floors, but it is placed too high in relation to the other buildings of the courtyard, and does not mark any difference in the mural texture of the building. According to Marshall the monument was built in about 150 A.D. and lasted until about 500 A.D. (*ibid.*: 123).

The facing of the plinth is of a "somewhat rough and ready kind compared with that of the prehistoric monuments beneath" (*ibid.*: 114), already glimpsed by Banerji and hence partly excavated by B. L. Dhama, under the direction of Marshall. The most curious characteristics of this plinth were, for Marshall himself, its abnormal height and an approach in the centre of its eastern side that was "more than usually elaborate" (*ibid.*; *see Figs. 5, 6*). We may note here also the total absence of mouldings and half-pillars. It was also impossible to establish whether the stairs of such an approach continued westwards, going up by one floor more. The drum of the stūpa, in unbacked bricks, and hollow inside (*Fig. 9*) was another detail that was difficult to explain. Its inner facing — Marshall says quoting Banerji's unpublished *Report* — "laid with care" and presenting "a smooth appearance", was originally intended to be hollow and "must have been plastered and painted" (*ibid.*: 115).

Marshall objects that on the internal facing there is no trace of plaster, that the painted fragments found by Banerji's assistant Wartekar, "while clearing the western side of the stupa plinth" could not be said to have come from inside the drum, that no Indian stūpa presented a similar typology and that the room was too vast to have been vaulted in unbacked bricks. None of the relic chambers Marshall had seen were "at all comparable in size with this supposed one at Mohenjo-daro (. . .) All things considered, therefore" — the famous archaeologist concluded — "I incline to the view that the interior of the drum was filled in as usual and covered with a dome of the customary pattern" (*ibid.*). The unlikely reconstruction of the stūpa proposed by Marshall, prudently suggested from north-west or from north-east, is reproduced here at *Fig. 13*. The relationship between plinth and drum can in no way correspond to the real one, the actual plinth being much higher, as one can see from the drawings given by Marshall himself (*cf. Figs. 2, 3*) as well as from photographs (*Figs. 5, 8*).

Marshall must however have continued to turn over and over in his mind the singularity of this hollow drum: at least until he believed he had found a solution in Stūpa A4 at Kālāwān (Taxila), excavated by himself. The plinth of this stūpa (*Fig. 19*) shows "a circular relic chamber, which is no less than 13 ft. 3 in. in diameter, with walls which start to cove inwards from a height of between 2 and 3 feet above the floor"

(Marshall 1951: 323). On the internal walls there were "several layers of whitewash" and it was therefore necessary to ask oneself why this chamber was not "permanently closed" as usual, and where the entrance was to be found — both problems without an answer. "A similar problem" — Marshall remembered — "is presented by the great Kushān stūpa at Mohenjo-daro in Sind, the relic chamber of which was also circular and finished off inside with mud plaster. In that case the evidence was not so clear as it is a Kalawan, and I felt inclined to take the view that the interior of the drum had been filled in and covered with a dome of the customary pattern. With this discovery, however, of this stūpa at Kālāwān, it is necessary to reconsider this view, since it is quite certain that in this case the chamber could not have been filled in" (ibid.: 324).

Actually, there are important differences between Stūpa A4 of Kālāwān and the one at Mohenjo-Daro. The first is that at Kālāwān the relic chamber is in the plinth, while at Mohenjo-Daro it is in the drum. The second is that in the case of Taxila the walls incline progressively inwards until they close without the need for a vault, in the Indian manner. This is not so at Mohenjo-Daro. It should be noted, however, that in the North-Western regions (this Marshall did not know) examples of large vaulted rooms in unbaked bricks are documented. I refer the reader to Room 36 at Tapa Sardār (Ghazni), which measured 8.00 x 7.70 m. (Taddei 1978: 578).<sup>3</sup> At Mohenjo-Daro, moreover, we are confronted by a stūpa built with two different materials: the plinth is built with baked bricks taken from the proto-historical ruins, and the drum is of unbaked bricks. This also could be explained, at least at first sight, because this mixed technique is found in other stūpas of Sind. The core of the Kahujo-daro stūpa near Mīrpur Khās, the most famous Buddhist monument of Sind, was circular and made of sun-dried bricks (Figs. 14, 15), the walls of burnt bricks around it "being only a few bricks thick" (Cousens 1929: 83). When Cousens examined the stūpa in 1909 "some portion of the core of the tower, of sun-dried bricks, protruded from the top" (ibid.: 82). This technique is documented by Cousens also at Depār Ghāngro, near Brahmanābād, whose stūpa had "a core of sun-dried bricks" (ibid.: 59 and Pl. XVII). Equally clear is the case of the stūpa at Sudheran, "built of unburnt brick faced with large burnt bricks". Here only "the mud core or tower" was actually visible — "all that was left of the original brick tower of the stūpa — which, like others of its kind was built of sun-dried bricks, regularly laid, with an outer shell or casing of ornamental burnt bricks" (ibid.: 101 and Pl. XXX).

The most interesting thing about the stūpa of Sudheran is its relic chamber, which is of rather a special type (Fig. 16). It is located at the same level at which the presumed one of Mohenjo-Daro is found, namely on the upper level of the plinth — the "terrace"

which at Sudheran "surrounded the base of the tower" (ibid.: 103). Having made the usual tunnel, Mr. Bhandarkar, whose words Cousens reports<sup>4</sup>, actually found "a dāgoba such as we find in the cave temples, standing 6 feet 9 inches high, composed of sun-dried bricks covered with plaster, the surface of which had been painted. It was completely built and embedded in the tower" (ibid.: 103-4). A relic chamber placed at the same level, attainable with difficulty through a shaft similar to that "down the centre of the dāgoba was found leading down to the relic chamber of the Sue Vihār stūpa near Bahāwalpūr, not far north-east of the Sind border": thus went Cousens' commentary to Bhandarkar's finding (ibid.: 104).

In spite of this last example, the stupa at Mohenjo-Daro cannot fail to puzzle. The difficulty does not arise so much from the fact that only the core of the drum is of unbaked brick (only the upper part of the stūpa might have been rebuilt in a period in which this technique was in use), as from the fact that the core presents a cavity of such large dimensions, not comparable with the one at Sudheran. Why ever would a core of this kind, consisting only of a thin circular wall of unbaked brick which then had to be encased by baked bricks, be built? This is not a credible way of building stūpas, and we could only conclude that the entire drum was of unbaked brick. But we would have in this case a drum reconstructed in a material different from that employed everywhere else in the area and in the stūpa itself, whose plinth, enlarged in periods III and IV<sup>5</sup>, is made entirely of baked bricks. It must be said also that this has no parallel in any other stūpa in Sind or in North-Western India.

We have seen how on the eastern side of the stūpa there is an unusual, elaborate "entrance", which is certainly unique among all stūpa entrances known to me in Western India and Central Asia. However, in this instance too the stūpa of Kahujo-daro near Mīrpur Khās, whose west side "was probably the front of the building" (ibid.: 85) comes to mind (Fig. 14). A terracotta image identified by van Lohuizen-de Leeuw (1979: 161-2 and Pl. 78; cf. Cousens, 1929: Fig. 14 on p. 95) as Padmāpaṇi comes from one of these niches. Moreover, there was perhaps "a staircase by which to ascend to the terrace round the base of the tower" (ibid.), which led to an upper *pradakṣiṇāpatha* as at Mohenjo-Daro (?) and as in the monumental ancient stūpas of Central and Southern India, for example Stūpa 1 at Sāñcī.

There are thus possible explanations, even if not fully satisfying, for some of the singularities of the stūpa at Mohenjo-Daro. Other difficulties remain. These regard the exaggerated height of the plinth in relation to the height of the drum that it must have had and the absence of mouldings and half-pillars, or of other architectural decorative elements indicating the presence of niches, as well as the absence of carved bricks, well known from the stūpas of Sind and Gujarat, as for example at Mīrpur Khās (Cousens,

1926: 88 and Pls. XX, XXIV, XXV A), at Sudheran (*ibid.*: Pl. XXXI), at Depār Ghāngro (*ibid.*: Pl. XI), at Jarak (*ibid.*: 108), at Devnīmōrī (Mehta and Chowdhary 1966: 139-40 and Pls. LVIII, LIX, LXI-LXV). Moreover, in the debris and on the different floors brought to light in the courtyard testifying the long life of the site, not the least fragment of a figure or object that could be recognized as having to do with a cult has ever been found. I refer not so much to those terracotta panels that decorated the plinths of other stūpas (the well known ones of Mīrpur Khās, but also those of Thūl Mīr Rukān; cf. Cousens 1926: 99) as to those small cult objects that a sacred area generally yields, from lamps to those small votive stūpas and tablets known — to confine ourselves to North-Western India — from the region of Ghazni (Taddei 1970) to pre-Tibetan Ladakh (Tucci 1932-XI: Pl. VII ff.) and also present here in Sind, as has been shown by van Lohuizen-de Leeuw (1979: 168-9).<sup>6</sup> It is thus a real pity that no documentation exists of the fragments of that Buddha image which according to Banerji was found at the western end of passage 65.

Around the main stūpa there were some minor ones, "but nothing was left of them except their plinths" (Marshall 1931: 116).

They were all removed to allow trial trenches with which to reach the proto-historical levels, and are documented by one photograph only (Fig. 4).

### The Monastery

When the plinth of the stūpa was intact, and on it stood the drum, the whole building had to be an enormous, overhanging structure, definitely to high and disproportionate, especially during periods corresponding to layers III and IV, when particularly thick retaining walls added to the plinth. Even more so in that it was located at the centre (ideal, not geometric) of a not very large courtyard around which were arranged the cells and other rooms of a monastery — itself no less unusual than the stūpa. It too is built with baked bricks taken from the proto-historical buildings, but stuck together with mud instead of mud and gypsum (Marshall 1931: 116). Originally a two-storeyed structure, it must have had a wooden roof and have been preceded by a wooden verandah "carried on brackets instead of the more usual pillars, since the space between the stūpa and cells was too constricted for a pillared verandah" (*ibid.*: 117). How otherwise could one explain "the large quantities of ashes found by Mr. Banerji in the courtyard, on the plinth of the stūpa and in the cells — the outcome, obviously, of a general conflagration" (*ibid.*)? In the monastery various phases are documented too. Here is

for example the "Assembly Hall" at the north-east corner (Fig. 1), whose roof was at first supported by three central pillars, and subsequently, the room on the south side having been made smaller, by six pillars to which half-pillars along the walls correspond. Also in the cells' floors which "were sometimes lower than the corresponding floor of the courtyard" (*ibid.*: 119) are documented, as for example in Room 24, where the difference in level between its last floor and the corresponding one outside is about 1 ft. 6 in. (ca. 45 cm.). The cells comprise one of the more evident singularities of the monastery. They appear to have consisted for the major part of two rooms, contrary to universally documented custom. The cells of Buddhist monasteries correspond in fact to a very precise type, spread from the Ganges valley and beyond to North-Western India and Central Asia, from Nālandā (Fig. 20) to Taxila (Fig. 17), to mention two of the most well-known sites. Around a quadrangular courtyard single rooms are arranged, whose door opening, provided with only one jamb, is generally located immediately next to the adjacent cell.<sup>7</sup> The cells are obviously all alike, or else they present negligible differences. Marshall writes that at Mohenjo-Daro the inner room was meant for sleeping and the outer one for living purposes (*ibid.*: 119). But what about the two symmetrical groups of rooms 41-42-43 and 46-47-48 (Figs. 1, 10)? Here there are cells not of two rooms but of three, the third being a sort of dead-end corridor. On the other hand, we have also cells of only one room, as for example Nos. 27 (Fig. 12), 28, 29. As regards rooms Nos. 25, 27, 29, of fairly large dimensions, Marshall himself does not believe that they are cells: "as there is no sleeping room connected with them ... it is probable ... that they were used for other purposes" (*ibid.*). The layout of the monastery and the differences between the cells constitute a considerable problem, which already in itself indicates that this monastery is very much *sui generis*. But there is more.

On the eastern side of the quadrangle there are no cells but four rooms (Fig. 1). Room No. 4 would be the "Entrance Hall". This is Marshall's idea, since according to Banerji the entrance to the quadrangle "lay through a pillared hall in the north-eastern corner" (Banerji 1922-3: 102), that is to say through the room that Marshall calls "Assembly Hall". Marshall — I believe — thought that the entrance was through No. 4 since the room is aligned with the stūpa, and an entrance must have existed somewhere. The entire eastern side of the Stūpa Area actually overlooks a steep escarpment, and today it is not easy to understand how and why the entrance had to be on this side. The ideas of Banerji and Marshall on this point owe more to exclusion than to evidence.

North of the entrance there is a rectangular room, No. 3, supposed to be "a small chapel, in which Mr. Banerji found eight fragments of stucco, painted with alternating bands of red and black and belonging, as he supposed, to the robe (sanghaṭī [sic]) of a Buddha

figure, as well as the torso of a clay image of a Bodhisattva with a necklace or garland, coloured red, around his neck" (*ibid.*: 117). These fragments, like the others in passage 65 and others yet again (*cf. infra*) have never been published, and apparently have never been seen even by Marshall. I shall limit myself, therefore, to observing that it is not easy to imagine a *saṃghāṭi* "painted with alternating bands of black and red", even if these should be decayed colours. Looking at the plan (*Fig. 1*), chapel No. 3 seems to have been made by altering an earlier room whose entrance from the *pradakṣiṇāpatha* side was closed.<sup>8</sup> The pedestal of the image stood on this side of the room, or so it seems. It is a most curious arrangement. I do not know any other example of a chapel placed along the *pradakṣiṇāpatha* of a stūpa whose image has its back turned to the main stūpa.

At the two extremities of the eastern side there are two large rectangular rooms, Nos. 1 and 5. The first has already been mentioned. The second was also altered, though without yet doubling the number of pillars, but rather widening the outermost ones (M and O on plan at *Fig. 1*). Nothing indicates that Room 1 was the Assembly Hall, "a usual if not indispensable adjunct in the larger monasteries of this period", as Marshall says (*ibid.*). As far at least as its second phase is regarded, this idea should be rejected, because the space between the four walls with half-pillars and the six central pillars is very limited. It would not have made sense to gather monks in a place where they could not even be seen. As far as room No. 5 is concerned, Marshall writes that the use to which it was put "can only be surmised" (*ibid.*: 118). It is not the refectory, Marshall explains,<sup>9</sup> because, in his opinion, this is more appropriately located elsewhere.

Let us consider rooms Nos. 26, 27a, 29a, 30a on the western side, belonging to layer I. Their walls "are not bounded with those of the cells in front of them" (*ibid.*: 119), and they may thus have been "a subsequent addition." "I surmise" — writes Marshall — "that they served as kitchens, pantries and store-rooms, and, if this surmise is correct, it is highly improbable that they were contemporary with the original edifice. Up to the end of the third century, if not later, it was unusual to have kitchens, pantries, and the like attached to monasteries. Before that the monks seem to have begged and eaten their food in the towns, or to have prepared it, each for himself, in his own cell. It was not until conditions became more luxurious that common kitchens, storerooms, and other such amenities were provided, and the monks thus enabled to devote more time to their religious and literary activities" (*ibid.*).

This *ad hoc* reconstruction of Buddhism, so simply-mindedly evolutionist, is accompanied by a tranquillizing and respectable interpretation of the complex: next to unusual two and three roomed cells for monks (surely destined for the most religious and literary ones . . .) are an Assembly Hall, a Common Room as

in British boarding-schools, kitchens, pantries and store-rooms. There is no evidence for all this, but the monastery is created. And yet, not everything works out. The long and narrow room No. 40 (which from the plan — here *Fig. 1* — appears to have been closed at the time of layer II) could indeed be another "image shrine, like No. 3; but it is hardly likely that there would have been two such shrines in the residential quarters" (*ibid.*). The far rooms on the north side (Nos. 53-58) "were added later on, some of them probably when the stūpa and monastery were repaired, probably in the third century A. D., and others still later, as indicated by the different hatching in the plan, (. . .) it is impossible to affirm anything definite regarding their purpose or date beyond the fact that they were later additions" (*ibid.*). This second series of rooms on the north side and the group of rooms on the west side, along which perhaps others, now lost, were located to close the corner, escape the logic of a monastery plan. They form not only an unusual second row of rooms and not only do not correspond to the usual monastic typology (on the north side, there are long narrow rectangular rooms), but seem also to lack any communication with the rooms which give on to the *pradakṣiṇāpatha*.

### The Findings

But there are other disconcerting details, relating to the material found in the monastery. In the narrow "torpedo-shaped" chamber No. 22 (*Fig. 11*) that Marshall shows to have been an integral part of the monastery when it was built, "Mr. Banerji found a large number of pots with pointed ends, which he took to be burial urns" as well as "two large earthen jars . . . which contained smaller burial urns, each of which in its turn contained uncalcined human bones, in crude crucible-shaped terra-cotta reliquaries" (*ibid.*: 120). This material is unequivocally proto-historical, and in this case not even Marshall manages to square the figures: "Are we to infer that these vessels remained in use right down to the time of the Kushāns? Or, in the alternative, that for some inscrutable reason the Buddhist monks preserved these relics of an older civilization in this small chamber? And how, again, are we to explain the presence of layers upon layers of pots and debris in a chamber provided with an open doorway and never apparently walled-up?" (*ibid.*). Marshall, however, accepts the data emerging from the excavation, "though *prima facie* it is unlikely that such a chamber would have been specially made amid the living quarters of the monks" (*ibid.*: 112), and seems to show no doubt about the nature of the monastery.

Also "a large earthen jar of the ghara type" found in room 27 (in the corner marked on the plan with an X; cf. Fig. 1; see also Fig. 12) contained "a number of the same kind of small vessels with pointed ends", containing in their turn fragments of bone mixed with a "thickish gluey soil" (*ibid.*). The problem is that also in this case the material is stratigraphically related to the monastery, and not to the lower proto-historical layers: "we can be quite sure" — Marshall writes — "not only that the jar is of Buddhist date but that it is relatively late, even at that" (*ibid.*).

According to Marshall's report, "the minor finds from the monastery quarter" — apart from the coins and a small head of which more will be said later — consisted of "a roughly made toy horse of terra-cotta, a miniature jar, and a fragment of a marble relic casket from Room 33;<sup>10</sup> a round lid of conch shell from Room 42" (*ibid.*: 122). In Banerji's brief account of excavations in ASIAR (1922-3: 103), we read that "the finds in site No. 1 consist of flint scrapers, cores, bouchers, dice of polished marble and terra-cotta; fragments of a marble chair, pieces of small images and umbrellas of white marble, oblation vessels of conch-shell, bangles and ornaments of conch, beads of various stones, copper and bronze, pipes of cornelian and pottery of various shapes", as well as "funeral urns of various size and shapes" that covered the whole site. We find ourselves confronted, therefore, with material that has nothing to do with the Buddhist period and which seems definitely to belong to the proto-historical town.<sup>11</sup>

Important exceptions are given by the coins and by "a tiny bearded head of painted stucco from Room 45, which is evidently a non-Indian type and, as Mr. Banerji suggests, may well have been meant to represent a Scytho-Parthian or Kushāna" (Marshall 1931: 122). Its finding spot is curious (room No. 45, according to Marshall's logic ought to be a monk's bed-room), but it may have "travelled". Unfortunately this head is unpublished, and from what he writes we may be allowed to assume that not even Marshall had ever seen it. If it was really a Kushāna head, this would be the only fragment — on the basis of the known iconographies of North-Western India and of the Ganges valley, where Kushāna donors are often represented beside images of the Buddha or of Bodhisattvas — that could accord with the nature of the site, given that the fragments of images from passage 65 and shrine 3, they too unpublished, have always been illegible.<sup>12</sup>

The coins discovered on the site are very numerous because most of them came from three authentic hidden treasure-hoards. The largest hoard, of 1684 coins, was found in room 34 "in an earthenware pot, which Mr. Banerji discovered just below the second floor... at a depth of 3 ft. 6 in. beneath the original surface" and consisted of square coins, "local issues of Sind, since they have been found at Mohenjo-daro and (more recently) at Jhukar near Lārkhāna, but nowhere else

in India" (*ibid.*; see note 14). According to N. G. Majumdar, who has given too brief an account of them, these coins cannot be earlier than the fifth century A.D. (Majumdar 1931: 128) and van Lohuizen-de Leeuw (1979: 172-3) considered them to be later, a possible issue of the Hindu dynasty ruling Sind in the second half of the 7th century. Almost all the other coins from the site are Vāsudeva I's. These latter are also found in the largest hoard of room 34, and form a second hoard of about 1100 coins found "during the excavations of 1927-8 in the Stūpa section" (Majumdar, 1931: 128, n. 1);<sup>13</sup> still others were found "scattered here and there in the débris" (Marshall 1931: 122) as well as in the smaller hoard of 76 coins in room 35 (*ibid.*).

It is well known that Kushāna coins were current long beyond the end of the dynasty, and that they were accompanied by imitations. The fact that in the hoard of 1684 coins, consisting for the most part of late local issues, coins of Vāsudeva I were also found and that other Kushāna coins were among the surface material and in the debris, indicates that also at Mohenjo-Daro Kushāna coinage was current at a late period. The numismatic material from the Stūpa Area appears to be stratigraphically connected with the site's last period of life. This can be said for sure, even if the stratigraphical information given by Marshall is inadequate. The hoard of 1684 coins was found "just below the second floor" of room 34, "at a depth of 3 ft. 6 in. beneath the original surface", but it is evident that at that point the second floor did not cover the hoard, composed of material that is too late to be referred to layer II. The hoard was in a pit, which can have been made at any time. This is probably also true for the small hoard of 76 coins in the adjacent room 35. As far as regards the other big hoard found in the Stūpa section" during the excavations directed by Mackay, the fact that the Kushāna coins of which it was composed were "badly corroded" although they were in a jar (Mackay 1937: 15; cf. here note 12) seems to indicate that they were collected in a "treasure-hoard" at a considerably later period than that of their issue.

The coins coming from the site thus do not give reliable information about the monuments, and do not seem in any case to be referable to the most ancient historical layers.

### Some More Problems

The plan of the Buddhist complex of Mohenjo-Daro is very unusual. Normally monastic groups have one or more stūpa courts where, next to the main stūpa, minor stūpas can be found. Moreover, chapels can open along the *pradakṣiṇāpatha*. Beside the stūpa court, but

clearly distinct from it, the monastery is located, formed by cells arranged along the sides of one or more courtyards. The reasons for such an arrangement can be easily understood. Monastic life has rules that cannot be continually disrupted by the presence of the faithful. Exceptions can be found, which can be explained, but the norm is very well documented. A notable exception, on the other side of the sub-continent, is given — to make an example — by the gigantic complex of Paharpur (Fig. 21). Here the courtyard is so vast, however, that there can be no interference between the monks' life in their cells arranged along the perimeter of the compound and the cult life around the central stūpa. Moreover, late architectonic and monastic organization in the East differs in part from that known to us in Western India, even in post-Kushāna period. See for example the monasteries of Tapa Sardār (Taddei 1978; Taddei/Verardi 1978) and of Adžhinatēpa (Litvinskij/Zemal' 1971), which have, from this point of view, a traditional layout. Also at Taxila, in Pippala's earliest monastery (Fig. 17) — which, according to Marshall's chronology dates to the Kushāna period — we have, if a comparison with Paharpur is possible, a similar exception (cf. Marshall 1951: 365 ff.). This can probably be explained by the fact that the site was a hermitage, the "public" stūpa of Taxila being the *Dharmarājikā*. Also in the monastic courtyards around this latter stūpa minor stūpas are found (cf. *ibid.*: Pls. 45, 61), but they too are destined for private worship.

The site of Devnīmori in Gujarat is perhaps the most appropriate example that we can consider, since — unlike Mīrpur Khās and the other sacred Buddhist areas of Sind — it has been extensively excavated. Because of its chronology, revised by Mme. van Lohuizen-de Leeuw (1979: 164 ff.) and of the architectonic and stylistic characteristics of its main stupa it is strictly linked with the monuments of Sind — they too dated by the late Dutch scholar to the 6th-7th century A.D. and not to the late Kushāna period (*ibid.*: 159 ff.). At Devnīmori the division between monastery and sacred area is respected as usual. The plan of Vihāra I (see Mehta and Chowdary 1966: between pp. 36 and 37) appears as a text-book example, utterly different from that at Mohenjo-Daro.

It is indeed difficult, in this last site, to imagine, as Marshall does, monks seated beneath the wooden verandah of the *pradakṣiṇāpatha*, where the space between stūpa and monastery is so limited. Even more difficult is it to imagine the presence of a "Bath" in the southeast corner of the same *pradakṣiṇāpatha* (close to one of the minor stūpas!), to be seen in the plan and in an old photograph (Figs. 1, 4) but not described by Marshall, who probably did not know how to explain its presence.

We might think that the stūpa of Mohenjo-Daro was not meant for public worship, that it too was a hermitage. This could explain the lack of any kind of decoration

on the stupa itself and, apart from an image in passage 65, the absence of those images that are indispensable for the *bhakti* of the faithful, but not in themselves necessary. This explanation, however, does not fit. The stūpa of Mohenjo-Daro is too big to have been built expressly for a similar purpose. Being built on the higher point of the ruins of the proto-historical town, it is made to attract attention, for the faithful. The monumental stairway on the eastern side, moreover, and perhaps even the presence of an upper *pradakṣiṇāpatha*, do not accord with such a hypothesis.

For these reasons, a comparison between the sacred area of Mohenjo-Daro and the unusual structures brought to light in Mound B at Jaṇḍiāl (Taxila), which for certain aspects could be made (see Fig. 18), does not seem to be valid too. The rooms that surround the Jaṇḍiāl stūpa are neither cells or chapels (with the exception of a small chapel in Court T). Marshall (1951: 356) underlines "the unusual plan of foundations" and observes that "In the Saka-Parthian period to which the stūpa is referable, we should not, of course, expect to find a quadrangle enclosed by rows of symmetrical cells, such as are characteristic of later monasteries, nor can we in fact be sure that any of the surviving chambers were used for residential purposes". The chronology of Taxila needs to be revised, and the structures of Mound B at Jaṇḍiāl might prove considerably later than has been thought, and, therefore, closer to those at Mohenjo-Daro but their fragmentary nature and scarce decipherability prevent us from saying more.

From the stratigraphical point of view, two important points must be emphasized. First of all, "under the platform [that is to say the plinth] of the existing stūpa a thick layer of ashes was discovered, proving that the existing shrine was built on the ruins of an earlier one" (Banerji 1922-3: 103). Actually, the layer of burnt material does not divide the Buddhist period from the proto-historical one. It will be remembered that "the walls of the earliest period and a pavement were found below the level of the ashes over which the platform of the stūpa was built" (*ibid.*). There is, therefore, a clearly recognizable gap between the earliest Buddhist layer and the subsequent ones. On the other hand, "from the sectional drawings on Pls. XVI (here Figs. 2, 3) and XVIII it will be seen that the prehistoric remains in the Stūpa Area commence immediately below the earliest Buddhist pavements. Indeed, it was because they happened to be so close to the surface that Mr. Banerji first lighted upon them when excavating the monastery" (Marshall 1931: 123). Thus there is no stratigraphical gap between proto-historical buildings and Buddhist monuments. The monuments of layer I must have been built, therefore, soon after razing the earlier ones.

It is the building technique (on which more will be said on a future occasion) that distinguishes the historical(?) from the proto-historical layers. In the Buddhist ruins

we find only bricks being re-used, provided of course that the assumption is valid according to which the proto-historical builders, as such, always used a better technique and those of the Kushāna or Gupta period, as such, a worse one. Such an assumption is certainly in line with the Indian theories about the progressive deterioration of this last *yuga*, but cannot in itself be said to be fully convincing.

The second important point, which has already been mentioned, is that according to Banerji, at the beginning of the excavation the plinth of the stūpa (but not the drum in unbaked bricks) was "covered with ashes" (Banerji 1922-3: 102) and that "the entire area of site No. 1 was covered with funeral urns" of a proto-historical type. This accords with the findings of proto-historical material in room 22 and 27, but stratigraphically would suggest a surprising conclusion: that the whole area should *not* be referred to the Buddhist period.

There are however findings that indicate beyond any doubt that the site was inhabited in the first centuries A.D. The fragments of painted plaster with inscriptions in *brāhmī* and *kharoṣṭhī* alphabets (Marshall 1931: 116), the fragments of pottery "bearing *Brāhmī* inscriptions... discovered by Mr. Banerji and subsequent excavators in chambers around the Stūpa and amidst the loose debris covering the surface of the Bath area" (Majumdar 1931: 129) as well as the head of a Kushāna personage, all indicate that the site was inhabited more than episodically in Kushāna time, whereas the coins show that people have settled here even in later times. What kind of settlement was there? We are confronted with stratigraphical and typological data that are contradictory. After a visit to the site, but before having been able to examine the findings, one is inclined to think that we have here a monumental area that was partly re-utilized and/or re-built in the historical period, but that not all the buildings are either wholly Kushāna or Gupta and post-Gupta.<sup>14</sup> This could perhaps explain the unusual layout of the sacred area. The stūpa would thus be un-typical because it is an adaptation of an earlier monument; the position and form of the monastery are so unusual because it would have been convenient to make use of earlier structures, which, all things considered, were still utilizable.

The presence of so many hoards of coins is surprising. One would say that the Stūpa Area and, with it, the whole area of sector SD comprised between Block 2 and Block 8, from which material from the historical period comes too and which is only recorded in passing by Mackay (1937: 15 ff.)<sup>15</sup> was a late inhabited area that made use of proto-historical structures. This does not necessarily preclude either an earlier construction of a stūpa or of a monastery, nor that these structures, in their turn, should have been built by adapting preceding monuments.

The unusual nature of the Buddhist monuments of

Mohenjo-Daro, the unclear stratigraphy (and, where it is clear, showing the contrary of what we would expect) as well as the absence of Buddhist iconographical material indicate the need for further study. Apart from possible new trial trenches, it will be necessary to collect and examine such findings as the inscribed pottery, the inscribed painted fragments of plaster, the fragments of images and the coins, of which so far we have so scanty a documentation.

#### Addendum

This article was already in press when the excavation Report submitted by R. D. Banerji to J. Marshall was unexpectedly published in 1984 by the Prithivi Prakashan of Varanasi under the title *Mohenjo-daro. A Forgotten Report*. Although Marshall made use of the information contained in the report for the chapter on the Stūpa Area in his work on Mohenjo-Daro, he never allowed Banerji's work to be published. The Prithivi Prakashan is therefore to be praised for the enterprise. Unfortunately the published text is not accompanied by the photographic material envisaged by the author, and this makes it harder to read than if it were possible to check Banerji's statements by consulting the photographs.

A reading of the report does not alter the content of the above pages. Individual points could be examined at greater length now, but the crucial problem of the nature of the site as expounded above remains unchanged. However dissatisfied Marshall was with Banerji's excavation work, which had not been carried out according to stratigraphical criteria, he nevertheless made an accurate if not over-concise summary of the report, so that its publication does not disclose anything particularly new. It would be useful and interesting, however, — though long and difficult — to attempt in a future to collate the photographs of the objects found by Banerji in the Stūpa Area. From his description they appear to be mainly proto-historical, though the absence of reliable stratigraphical information regarding their exact finding spots allows for many possible interpretations.

## Footnotes

- 1 I spent a brief study period at Mohenjo-Daro at the end of February 1984, collaborating in the work of the RWTH Aachen and IsMEO of Rome. My visit was made possible thanks to funds assigned by the Ministero della Pubblica Istruzione to a project for archaeological research in Afghanistan and North-Western India directed by Prof. Maurizio Taddei of the Istituto Universitario Orientale of Naples.
- 2 They had excavated "beneath the hollow middle of the drum, to a depth of some 14 feet" (Marshall 1931: 115). One must not confuse the hole made by the treasure-seekers with the cavity in the drum of unbaked bricks.
- 3 The room has not really been published yet. One may see a photograph of it in *IsMEO* 1969: Fig. 9. An example of the special unbaked bricks strengthened with wooden sticks used to vault these large rooms has been given by Galdieri 1982: Fig. 14, 3-4, p. 38.
- 4 Cf. Bhandarkar 1914-5: 89-96.
- 5 Marshall uses Roman numerals to indicate the layers from the historical period and Arabic numerals for the proto-historical layers.
- 6 Actually, these votive stūpas and tablets are comparatively late, belonging to the post-Kushāna period. But as we shall see further on, there are reasons, emphasized by van Lohuizen-de Leeuw (1979), for considering the historical monuments of Sind to be later than has been usually been thought.
- 7 There are, however, examples in which the opening of the door is found in the centre of the wall. See here Fig. 21.
- 8 The hatching in the plan (here Fig. 1) shows, however, that all the walls belong to the same period.
- 9 "It may have been used as a 'common room', or at one time perhaps as a refectory", says Marshall (1931: 118), according to whom this room being "more simply designed" than No. 1 (in fact there are no half-pillars), is less likely to have been the "Assembly Hall". From a functional point of view, if anything, the contrary is true.
- 10 I intend to come to the nature of this "relic casket" on a future occasion.
- 11 As Marshall says (1931: 123), Banerji, at the beginning of the excavation, "lighted upon" the prehistoric remains "because they happened to be so close to the surface", and this can certainly partly explain the list of proto-historical material made by Banerji, who referred it, not knowing otherwise, to the Buddhist sacred area. Only partly, however. As has already been seen, and as will be said again below, "the entire area of site No. 1 was covered with funeral urns of various size and shapes" (Banerji 1922-3: 103). Moreover, the same brief list given by Marshall indicates that the findings are suspect (see the "toy horse of terra-cotta").
- 12 Probably Marshall never saw these fragments (of which he gives no photographs in his report), nor those fragments of "frescoes" found by Banerji's assistant Wartekar (cf. *supra*). The ambiguity with which Marshall deals with this point probably shows that he is trying to cover up his subordinates and his own neglect. He arrived first at Mohenjo-Daro only in the summer of 1924, and the excavation had been begun by Banerji in 1921.
- 13 Mackay writes: "in the excavation of Divinity Street we were so fortunate as to find a considerable hoard of Kushāna coins... numbered 1,078 in all, and despite being in a jar were very badly corroded. (...) This hoard of coins was found... beneath the floor of room 1 of the Buddhist monastery (Pl. VI) which partly overlay Divinity Street, that street having long since been filled up with debris and windborne dust" (Mackay 1937: 15-6 and Pls. LXXI, 1, 12; LXXXII, 11-7). One must not confuse "room 1" in Mackay's numeration with the "Assembly Hall" on the eastern side of the *pradakṣiṇā* patha.
- 14 All the Buddhist areas of Sind have yielded material that is unequivocally late-Gupta, and probably even post-Gupta, and not Kushāna. As we have seen, it is Mme. van Lohuizen-de Leeuw's opinion that all the historical monuments of Sind should be considered later than usually thought, forwarding convincing reasons to support this (see van Lohuizen-de Leeuw 1979). It may be interesting to recollect here that a non-monumental site as Mound 8 at Jhukar, fairly near Mohenjo-Daro, excavated by Majumdar, revealed the existence of dwellings of unbaked bricks that go back, according to him, to the fifth century A.D. (Majumdar 1934: 7). It is from this mound that the local coins found also at Mohenjo-Daro, and judged by van Lohuizen-de Leeuw to be probably of a later date, come from. Here too, associated with them, were Kushāna coins. Next to a Gandharan toilet-tray (*ibid.*: 18 and Pl. XIII, 2), to a small head that is not easily identifiable but which I would say is Gupta or post-Gupta (*ibid.*: 17 and Pl. XIII, 1), and to sealings of Shaivite character (cf. for example Inv. No. JK 763, for which *ibid.*: 17), were found "potsherds representing Buddha in relief, seated in preaching attitude, in temple with Dharmacakra symbol on śikhara" (JK 816, for which cf. *ibid.*: 16 and Pl. XIV, 26) and a "Limestone fragment representing a Bodhisattva figure (...)" (JK 71, for which *ibid.*: 18 and Pl. XIV, 27), which do not belong to the artistic tradition of Kushāna India, but to Gupta tradition.
- 15 Also this material will be examined on a future occasion, when Mackay's excavations are considered.

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Fig. 1 Mohenjo-Daro. Plan of stūpa and monastery according to Marshall (from Marshall 1931: Pl. XVI)

Figs. 2, 3 Mohenjo-Daro. Sections on AB and CD of stūpa and monastery according to Marshall (from Marshall 1931: Pl. XVI).

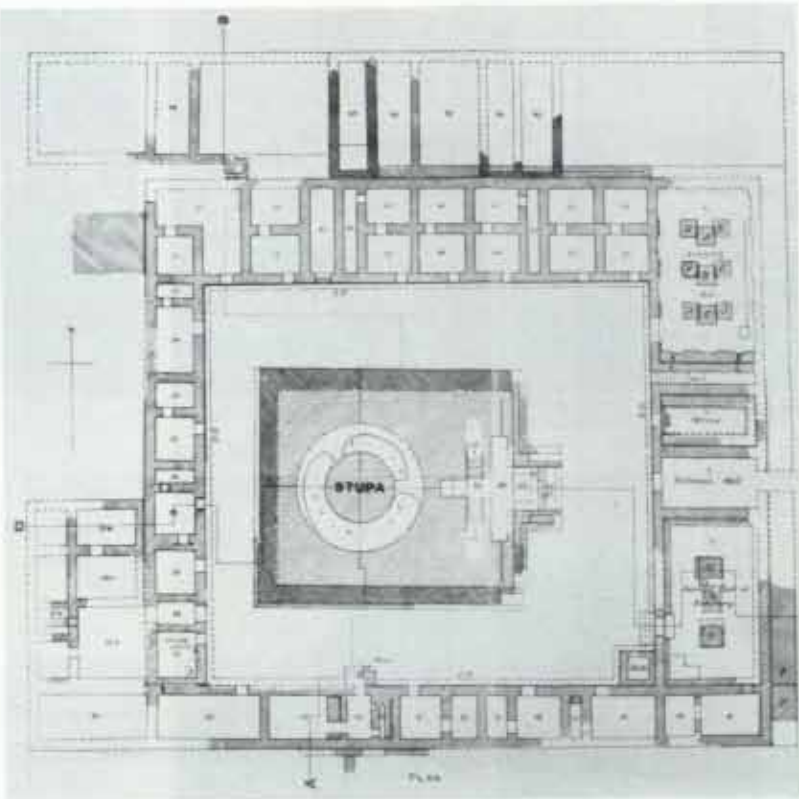


Fig. 1

Fig. 2

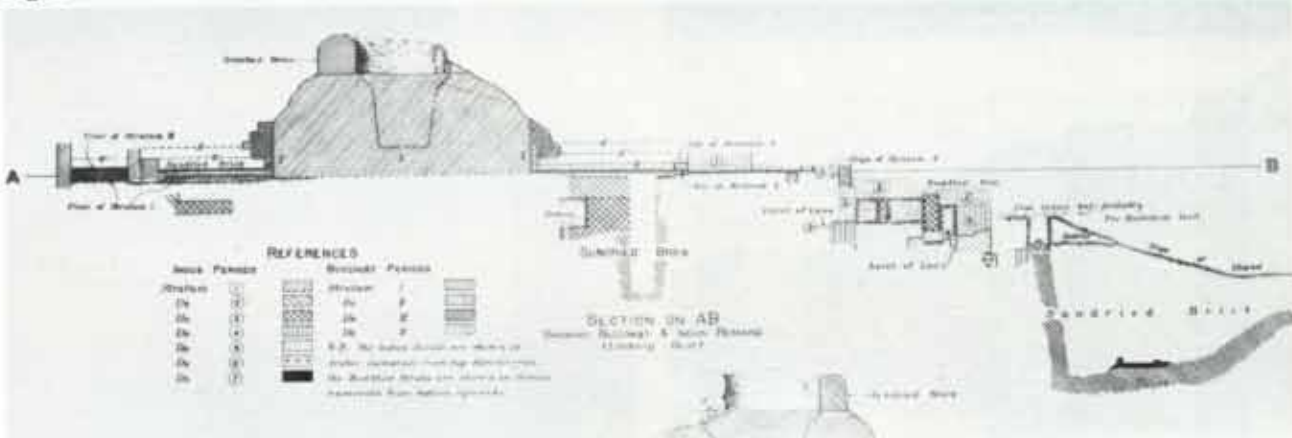


Fig. 3





**Fig. 4**



**Fig. 7**



**Fig. 5**



**Fig. 6**



**Fig. 8**



**Fig. 9**

**Fig. 4** Mohenjo-Daro. Stupa Area. Eastern side of courtyard showing structures removed later on (from Marshall 1931: PL. XV b).

**Fig. 5** Mohenjo-Daro. The stupa. (Dep. CS. Neg. L. 15002/26, IsMEO, Rome. Photo G. Verardi).

**Fig. 6** Mohenjo-Daro. "Entrance" and stairway of stupa (Dep. CS. Neg. L. 15002/25, IsMEO, Rome. Photo G. Verardi).

**Fig. 7** Mohenjo-Daro. Western side of stupa plinth (Dep. CS. Neg. L. 15002/21, IsMEO, Rome. Photo G. Verardi).

**Fig. 8** Mohenjo-Daro. Western side of stupa (Dep. CS. Neg. 15002/23, IsMEO, Rome. Photo G. Verardi).

**Fig. 9** Mohenjo-Daro. Hollow drum of stupa (Dep. CS. Neg. L. 15002/33, IsMEO, Rome. Photo G. Verardi).



Fig. 10



Fig. 11



Fig. 12

**Fig. 10** Mohenjo-Daro. Monastery. Rooms 46-47-48 (left), 49-50 (centre), 51-52 (right) (Dep. CS. Neg. 15002/29, IsMEO, Rome. Photo G. Verardi).

**Fig. 11** Mohenjo-Daro. Monastery. Room 21 (left), 22 and 23 (centre) (Dep. CS. Neg. 15005/30, IsMEO, Rome. Photo G. Verardi).

**Fig. 12** Mohenjo-Daro. Monastery. Room 27 (Dep. CS. Neg. L. 15005/17, IsMEO, Rome. Photo G. Verardi).



Fig. 13



Fig. 14



Fig. 15



Fig. 16

**Fig. 13** Conjectural restoration of stupa at Mohenjo-Daro according to Marshall (from Marshall 1931: Fig. 9 p. 116).

**Fig. 14** Stupa at Mirpur Khās (from Cousens 1909-10: Pl. XXX b).

**Fig. 15** Plan of stupa at Mirpur Khās according to Cousens (from Cousens 1909-10: Pl. XXX).

**Fig. 16** Relic chamber of stupa at Sudheran (from Cousens 1929: Fig. 16 p. 103).

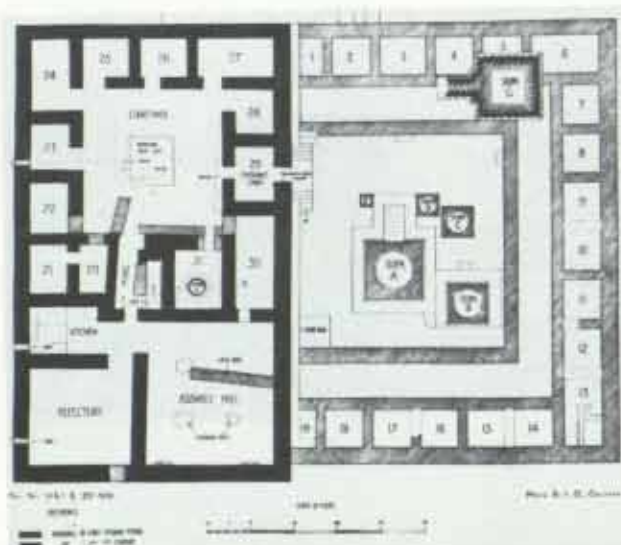


Fig. 17

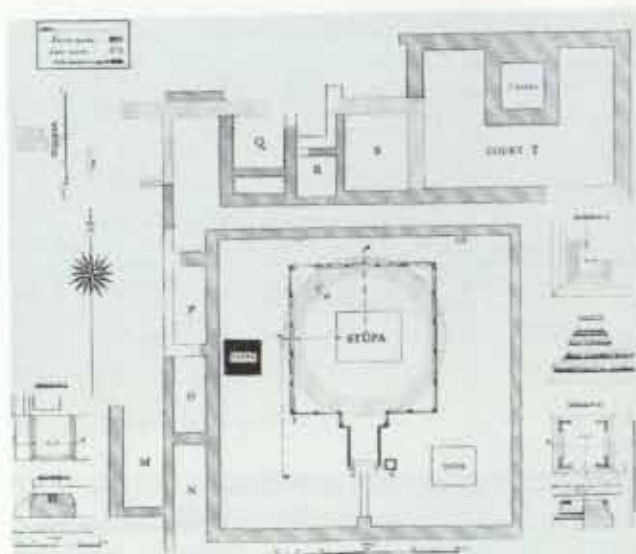


Fig. 18

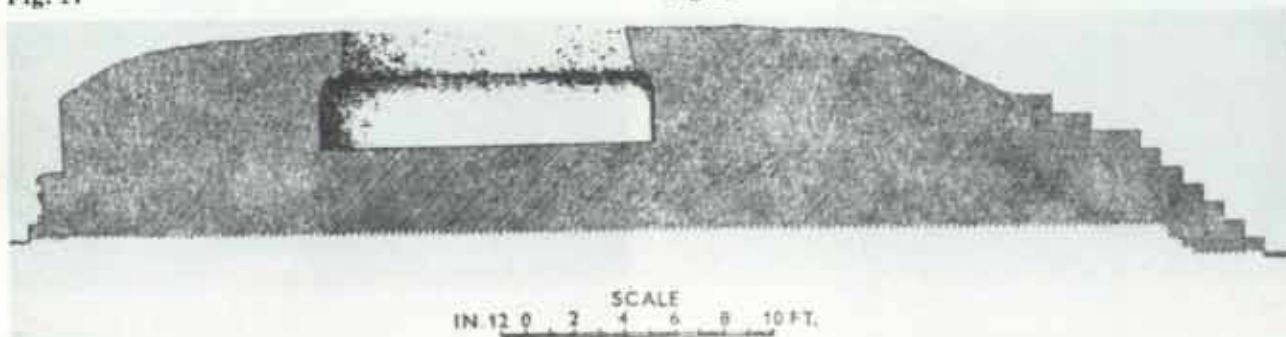


Fig. 19

Fig. 21

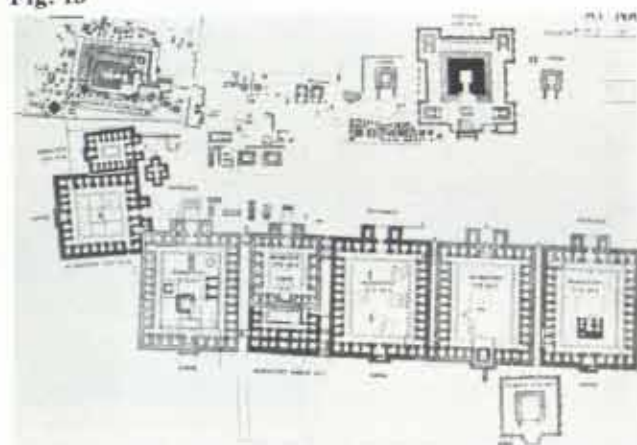


Fig. 20

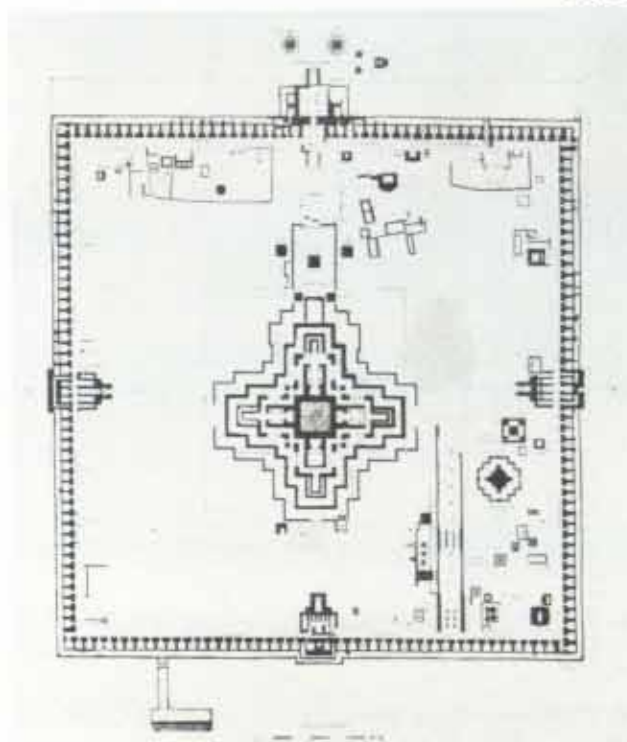


Fig. 17 Pippala (Taxila). Monastery (from Marshall 1951: Pl. 98 a).

Fig. 18 Jandial (Taxila). Stupa and surrounding structures in Mound B (from Marshall 1951: Pl. 91).

Fig. 19 Kālawān (Taxila). Section of stupa A4 (from Marshall 1951: Pl. 73 d).

Fig. 20 Nālandā. Monasteries Nos. 1-8 and 18 (from ASIAR 1930-4: Part 2, Pl. LXXI).

Fig. 21 Paharpur. Stupa compound (from ASIAR 1930-4: Part 2, Pl. XLVII).

# The Theriomorphic Stone Sculpture from Mohenjo-Daro Reconsidered

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Aachen

Today, after more than 60 years of archaeological research at various Harappan sites, we know that Vats was right in hoping to find more stone sculptures, in particular human statues: in the course of further diggings at Mohenjo-Daro a total of 16 stone sculptures were excavated<sup>2</sup> (though not "Sumerian" and mainly fragmentary). Up to the present, this evidence is unique for the settlements of the greater Indus Valley and it might indicate that during a certain period of time Mohenjo-Daro played a major role as an ideological centre within the Harappan realm.

Most of the anthropomorphic stone statues found at Mohenjo-Daro have to be related to the late occupational period of the site.<sup>3</sup> Seven of them, — if the reconstruction of the steatite bust DK 1909<sup>4</sup> is included —, represent half-squatting, half-kneeling males whose statuesque posture, costume, and beard bears a close resemblance to the rendering of eight bearded individuals taking part in a "banquet", a scene depicted on a silver vessel which was rescued from a dealer's shop in the bazaar of Kabul and attributed by Pottier and others<sup>5</sup> to the inventory of Bactrian grave goods dated around the turn of the 3rd millennium B.C.. Whether this "banquet" scene has to be interpreted as purely secular<sup>6</sup> or religious<sup>7</sup> in character is not actually the problematic point here since the representation clearly relates to a ceremony with ideological implications reflecting either an economic (agrarian)<sup>8</sup> or a cultic (religious) background.

It has been suggested that the squatting individuals on the Bactrian silver vessel and the full length anthropomorphic stone sculptures from Mohenjo-Daro should — against the background of their iconographical traits — be regarded as interrelated.<sup>9</sup> Yet this correspondence does not show the particular connotation of the sculptures; the iconographic parallels provide significant clues for the phenomenon of mutual ideological conceptions within the greater Indo-Iranian borderlands which were a result of increasing intercultural contacts at the end of the 3rd, resp. at the beginning of the 2nd millennium B.C..<sup>10</sup>

The theriomorphic sculpture in the round from Mohenjo-Daro appears to be just as significant as the anthropomorphic statues, particularly as this settlement is the only Harappan site where zoomorphic stone sculptures of a larger size have so far been found.<sup>11</sup> These animal images bear certain iconographic characteristics which connect them with other groups of figurative devices from areas outside the basic Harappan sphere.

Four out of a total of five<sup>12</sup> relatively large animal images are of an identical motif: they represent reclining caprids with fore- and hindlegs drawn under the body.

The identification of three of them has been a point of discussion throughout the past decades<sup>13</sup>, as the heads

*"Among the important finds are to be noticed firstly a limestone human headed sphinx of the Babylonian model (VS. 116, Sq. 2200 x 1800, Bs. 2') which is in the round and the first thing of its kind from Mohenjo-daro or Harappa. It gives promise of the possibility of finding human Sumerian figures. Unfortunately its identity owing to break of the front portion is not certain." (Diary of M. S. Vats 10/12/1925)*

When Vats noted these observations down in his diary<sup>1</sup> which he kept during the fieldwork at Mohenjo-Daro, he had indeed made an outstanding archaeological find (Fig. 1) since he had uncovered the first stone statue at a site belonging to the Indus-Civilization.

of the sculptures had been apparently knocked off long before the archaeologists arrived at the site.

With sculpture VS 116 (Fig. 1) Vats in the first instance, believed to have found a "human headed sphinx"<sup>14</sup>, but Mackay corrected this interpretation later by explaining the animal as a ram. (Marshall 1931: 360)

Nevertheless, Vats' presumption of a chimera was to have persistent consequences for the interpretation of further animal sculptures from Mohenjo-Daro: shortly after the first find had been made, two more stone statues of reclining animals were rescued during the same excavation campaign in winter 1925-26 on the "citadel" (SD 1109, Fig. 2) and on Harold Hargreaves' site in the lower town (HR 1072, Fig. 3).

A feature common to both of them is their representation on cubic pedestals firmly connected with them and that they were described by Marshall as "composite creature[s], part bull part ram and part elephant"<sup>15</sup>, an interpretation which seemed to find corroboration through certain fantastic creatures depicted on some of the Harappan steatite seals: "This image" (SD 1109) "calls to mind the curious composite animal represented on seals Nos. 377, 378, 380, and 381, with a ram's body, a human face, elephant's trunk etc. . . ."<sup>16</sup> "In the figure before us the head is badly broken, but there is no doubt about the ram's body and the elephant's trunk, though it is questionable whether it originally had a human head." (Marshall 1931: 360)

A closer examination of the fantastic animals on the seals, however, reveals some crucial differences<sup>17</sup> both within their group as between them and the stone sculptures under discussion:

1. The animals on the seals are portrayed with antlers which either resemble the horns of a Zebu (*Bos indicus*, L.) or those of a Markhor (*Capra falconeri*, Wagner).
2. The bodies of these creatures can not be ascribed to one single and distinct species. Some of them (e.g. E 1277 and HR 4952) show hindpaws and an upstanding slim tail, traits which do suggest physical characteristics of a cat<sup>18</sup>, and others (e.g. VS 1753) portray the shaggy skin of a Balkan sheep (*Ovis strepsiceros*).
3. Most of the chimeras on the seals wear a kind of garland around their necks, a decoration which is absent in the stone statues.
4. The seal creatures are depicted in a standing position, while the statues are rendered in a reclining pose.

These iconographical dissimilarities between the animal representations on the seals and the stone images should not be regarded as accidental and explained as resulting from the artistic licence presumed by the Harappan seal cutters and sculptors. On the contrary, one should expect that the artisans intended to portray different creatures when they represented them in a different manner and with distinctive attributes.

After all, a closer examination of the theriomorphic sculpture from Mohenjo-Daro betrays such a number of corresponding features<sup>19</sup> in subject, composition and working technique that they should be regarded as representations of an identical animal.

While Marshall, Mackay, Mode, Wheeler, and Allchins<sup>20</sup> interpreted the statues, in particular SD 1109 (Fig. 2) and HR 1072 (Fig. 3), as portrayals of fantastic beasts akin to the chimeras on the seals, Fairervis, During-Caspers and Pittman came to the conclusion that the sculptures should be understood as representations of an animal species belonging to the natural environment of the greater Indus Valley.<sup>21</sup> The thickened frontal ridge, a physical trait which had been explained as an elephant's trunk<sup>22</sup> before, was regarded by them as a "stylization of the neck mane" (Pittman 1984: 88) belonging to a natural breed, namely a mouflon (*ibid.*: 88), or a ram (Fairervis 1975: 285; During-Caspers 1986: 302).

The explanation of the ridged appendage as dewlap can in fact now be corroborated by another sculpture fragment of a squatting animal which was recovered as a surface find at Mohenjo-Daro in 1981.<sup>23</sup> Although incomplete, this statue provides valuable information since it is the only figure within this group of sculptures which is not headless (Fig. 4) and might therefore allow identification of the species represented. The image, measuring at present 20 cms in length, 16,5 cms in height and 12,5 cms in breadth, is made out of a yellowish limestone. Despite the weathering of the soft stone which resulted in a shallowing of the carving, it is beyond dispute that a naturalistic creature is represented here and by no means a fantastic being. The dewlap extending down the chest from below the mouth is rendered in an abstract manner, equally the sweeping horns describing an arc of 180 degrees, the drooping, floppy ears<sup>24</sup> and the eyes.

According to the expert judgement of Richard H. Meadow<sup>25</sup> the image represents a so-called Sind Ibex (*Capra aegagrus*, Erxleben or *Capra hircus*, L.), an indigenous species still found today in the mountainous regions of southern Baluchistan from the Makran coast near Pasni to Sind, Kohistan and the Kirthar Range.<sup>26</sup>

In its general composition the sculpture comes very close to VS 116 (Fig. 1), the first find of this kind made by Vats in 1925, particularly as both are shaped in a rather general and abstract manner without an elaborate trimming of the eyes and ears, the neck mane, the ridged horns and hoofed legs.

Apart from this, they have approx. the same dimensions<sup>27</sup> and are both conceived without a base, although it might be possible that they were originally set up on separately manufactured pedestals, as their bottom sides are carefully flattened and smoothed and show no traces of anatomical details.

Unfortunately the hindpart of the image U 81 036 (Fig. 5) is broken off, but from the slight twist of

the head to the right it can be surmised that it was represented in an identical position as the other statues which exhibit a recumbant pose so typical of resting ruminants: their weight is shifted to one side while the hindleg in question is drawn under their hind-quarters.

Image SD 1109 (Fig. 6) is the most elaborate example from Mohenjo-Daro where an illusion of unweight was obtained by hiding the left hindleg under the animal's body and by broadening the right flank of the figure asymmetrically. This tension provokes the perception of a body torsion which is strengthened by a gentle turn of the head to the right.

The photographic documentation of the Sind Volumes<sup>28</sup> has revealed two photographs of sculpture VS 116<sup>29</sup> (Fig. 1, Fig. 7), — each of them taken from the corresponding side —, which despite their poor quality demonstrate that the left hindleg of the animal was not shown (Fig. 1), while the right thigh was rendered in relief (Fig. 7). This artistic device was chosen in order to delude a torsion of the body.

A similar rendering was observed by E. Porada when she described the sculpture of a reclining "mouflon" from Iran, now in the Metropolitan Museum of Art<sup>30</sup>: "die hintere Körperpartie wurde nur auf einer Seite plastisch stärker behandelt, während auf der anderen eine helle Linie im Stein den Umriß des Beines andeutet" (Porada 1974: 163). Whereas E. Porada saw close parallels between this sculpture and mouflon images from Tepe Yahya<sup>31</sup>, H. Pittman<sup>32</sup> related the same sculpture to "those from the Indus Valley" and noted that it was "realistically rendered . . . with the weight thrown fully onto its left haunch, tucking the left hindleg under its body. Although the bottom of the statue is worn away, it is likely that this hidden leg was originally indicated there." (Pittman 1984: 88) In comparison with the animal statues from Mohenjo-Daro, however, it becomes more probable that the left haunch of the Metropolitan Museum's piece was purposely rendered without a pronounced hindleg in order to achieve the illusion of a body torsion.

Another feature noticed by E. Porada actually underlines the affiliation of the Iranian statue to the Harappan sculpture as "the head of the 'mouflon' is separated from the body by a subtle incision" (Porada 1974: 163), exactly as in the images from Mohenjo-Daro (Fig. 2, Fig. 4).

Against the background of these similarities, it can be surmised that the recumbant animal figure from Iran is congenial to the animal sculptures from Mohenjo-Daro, although it is still a problem whether their origin has to be ascribed to the greater Indus Valley or to the Near East.<sup>33</sup>

The artistic device of the body torsion had been observed for the earliest examples from the Near East in a cattle image from the Early Dynastic II Sara-Temple in Tell Agrab<sup>34</sup> and a recumbant animal figurine from the "dépot archaïque" at Susa<sup>35</sup> by

M. Behm-Blancke. He ascribed those two isolated phenomena from the first half of the 3rd millennium to a local workshop tradition concentrated either in the Diyala region (Behm-Blancke 1979: 17) or in the Susiana. (ibid.: 43) For a possible explanation of this phenomenon Behm-Blancke suggested that the torsion motif could have been a result of long distance east-west contacts focussing on the Diyala region during a certain time period, and referred to its cooccurrence in the Harappan Civilization. (Behm-Blancke 1979: 43)

In spite of this conclusive observation, a connection with the subcontinent does not coincide with the comparatively early emergence of the torsion motif in the Susiana and Diyala region with the present chronological background, against which the sculptural art from the Indus Valley has to be seen. And furthermore, we also seem to be confronted with a hiatus of this motif within the Near Eastern art from the first half of the 3rd millennium to the mid of the 2nd half of the 3rd millennium B. C. .

The excavations at Harappa and Mohenjo-Daro have revealed a considerable amount of small amulets (Fig. 8) made of paste, shell and steatite<sup>36</sup> which depict the same type of reclining animals.<sup>37</sup> Some of them even show, when examined from the back, a slight body torsion to the right and the rendering of others clearly shows that the left hindleg was hidden under the left haunch while the right leg was shown more or less in detail.

This characteristic twist, which can also be observed on a bronze figurine of a sitting "goat"<sup>38</sup> originally fixed onto a pin, indicates that they have to be regarded as minute copies of the stone models. Most probably the amulets were worn by Harappans as talismanic charms somehow related to the symbolical meaning of the sculptures. They might have functioned as substitutes for the presumably cultic connotation which the stone images had within Harappan society.

Where and how the stone statues were adored in Mohenjo-Daro is impossible to deduce from what we know of the archaeological record today. All four images seem to have been recovered from a secondary position in "Intermediate" and "Late" Harappan contexts<sup>39</sup>, as they had obviously already been removed from their original settings and demolished while the site was still occupied by Harappans, a sad lot which also befell the anthropomorphic stone statues in Mohenjo-Daro.<sup>40</sup>

Though the stimulus for this "iconoclasm" will in all probability remain a mystery, the destruction of the images might be taken as an indication of an ideological crisis which arose during the last decades of the Harappan Civilization, as a consequence of which the urban social order might have begun to disintegrate and finally collapsed completely.

Albeit, one remarkable feature of two of the images is still evident: HR 1072 (Fig. 3) and SD 1109 (Fig. 2) are represented on a cubic pedestal which is firmly

attached to the sculpture as it is hewn out of the same monolithic block of stone. By means of this artistic device, the animal is not only estranged from its "natural" habitat, but also elevated both physically and symbolically. The pedestal lends the images, despite their modest sizes, an unmistakably monumental quality which underlines their outstanding significance. The geometric base is an elementary vehicle to create distance and momentous value. It directs perception and thus defines a clear esthetic limit between the sculpture and the spectator (adorer?).

These two images are up to the present the only Harappan sculptures which emphasize this particular artistic device. But an observation made by E. During-Caspers provides a further argument for the assumption that the two unpedestalled animal statues from Mohenjo-Daro might have originally been placed on separate bases. In discussing the statue from the Metropolitan Museum of Art referred to above (cf. Porada 1974: 163; Pittman 1984: 88), During-Caspers mentioned "drill hole[s] . . . situated along the . . . flat and polished base . . ." which "can only be explained as a securing device in order to fasten this ram figure onto a pedestal or another support." (During-Caspers 1986: 299). Even if the fragmentary figure 81 U 036 (Fig. 4) from Mohenjo-Daro does not exhibit any drill hole in its bottom side and the original VS 116 (Fig. 1) could not be examined<sup>41</sup>, this still does not exclude the possibility that they had been furnished with drill holes and were both set up on bases.

On the whole, the device of an elevation of the images by means of pedestals on at least two of the statues and the numerous amulett copies suggests an ideological significance of the whole group of recumbent animal portrayals.

Unfortunately, the contents of their symbolical message can not be revealed unequivocally on the basis of our present knowledge from the Indus Valley proper. Should we, as E. During-Caspers had previously proposed, see them in a wider context with two similar animal representations from the well chamber in Diraz on Bahrain? (During-Caspers 1976; 1986)

The findspot of these images close to a well chamber could indeed suggest that they were "connected with a water cult of deep religious significance" (During-Caspers 1976: 17) particularly as "Dilmun", a name so frequently mentioned in the Sumerian cuneiform texts, and commonly related to the "eastern shores of the Persian Gulf" (Kramer 1944: 54) and the island of Bahrain, is a "holy land, a pure and clean place" (ibid.: 55) where the myth of Enki, the great Sumerian water god, and Ninhursag, his spouse, took place, and where temples were "fundamentally associated with fresh water". (Bibby 1986: 194) At an earlier date Bibby had suggested that Enki was originally a Dilmunite god and that later the myth had travelled from there to Mesopotamia. (Bibby 1977: 90)

K. Al Nashef has recently rejected any earlier supposed

worship of the Sumerian pantheon in Dilmun and has pointed out that Near Eastern sources simply referred to a Dilmunite deity pair (Inzag and Meskilak) which was identified by the Sumerians with their main god couple from Eridu, namely Enki and Damgalnuna. (Al Nashef 1986: 348)

Although nowadays we seem to have quite an advanced knowledge of the contacts between the Arabian peninsula, the Sumerian mainland and the Indus Valley proper during the second half of the 3rd millennium B. C., the observations made by Al Nashef actually underline the general problem that cultural (and economical) relations between these countries were obviously of a more complicated nature than presently deducible from the archaeological and textual evidence. It must therefore be taken into account that metaphysical and iconographical ideas travelled from one cultural entity to the other, whilst their basic notions were adapted and/or accommodated to the existing local conceptions. Therefore, partly due to the fragmentary state of workmanship and preservation of the sculptures from Bahrain (During-Caspers 1986: 299, Figs. 119-120), it cannot be ascertained whether these images depicted the identical animal species and corresponding inherent idea as the Harappan sculpture from Mohenjo-Daro. Moreover, they were apparently not designed in the same contorted pose which is so characteristic of the sculptures from the Indus Valley and the isolated find from Iran.

But in order to bring more fantasy into the speculation of a worship concerning the Sumerian water god, an interesting iconographical feature of the Near Eastern glyptic art should be mentioned: Enki, who is commonly depicted with two riverstreams flowing out of his shoulders or a vessel held in his hands, is sometimes also illustrated while "his foot may rest on an ibex, emblem of sweet underground springs, the Apsu." (Jacobsen 1976: 111)

As W. Hartner has pointed out, the recognition of star configurations on the Sumerian horizon might have led to an early correlation of the stellar signs with gods, — personified in human or animal shape —, who were responsible for the cosmic and worldly order.

A recognition of the regular movements of at first sight apparently confuse and abstract star constellations, which on the other hand obviously influenced seasonal changes in nature (spring, summer, autumn and winter) might indeed have led to an assimilation of these curiosities to human fantasy and mythological thought. Metaphorical images, animals and human beings, finally gods, were thus associated with the stellar constellations, which became responsible for the laws of nature and mankind as incarnations of the celestial phenomena.

The constellation of "the classical Aquarius ("Water Carrier")" can iconographically "be traced back to Sumerian times as one of the particularly favoured symbols, representing a male deity, often standing on

top of the Sacred Mountain, and pouring water from two vases". (Hartner 1965: 9) But, as W. Hartner has argued, it might have had its origins in iconographical representations depicting "the Ibex or Mouflon, which comprised in all probability all the main stars both of Capricorn and Aquarius", which "was actually the zodiacal constellation indicating by its heliacal rising the Winter solstice or a date close to it." (ibid.: 9)

In the following Hartner resumed Near Eastern iconographical motifs representing animal combats<sup>42</sup> which, according to his arguments, have to be seen as illustrative embodiments, artistically and ideologically transformed conceptions concerning celestial events, which periodically appeared on the Sumerian horizon. The constant reoccurrence of these iconographical themes throughout centuries<sup>43</sup> was thus interpreted as giving witness to the ideological significance celestial and successive seasonal changes had within human perception and mythological thought.

But should we assume that the Sumerian conceptions of astral events, persistent as they obviously were<sup>44</sup>, were also known to the people of the Harappan Civilization?

It would definitely go far beyond the scope of this paper and our present knowledge to exemplify possible, but mostly hidden and very scanty indicators for connections within the ideology of Near Eastern, Dilmunite and finally the greater Indus Valley areas.

What we believe to know of the subcontinent for the period of the second half of the 3rd millennium is that the Harappans were apparently devoted to some kind of water cult<sup>45</sup> and that they were acquainted with an orientation system which was sophisticated enough to presume stellar observations.<sup>46</sup>

This, however, does not yet permit the assumption of close connections with the ideological conceptions prevailing in the Near East. We are still faced with the problem that we can hardly discern the dimensions of intercultural relationships between the peoples of the late 3rd millennium B.C., though mutual contacts have to be regarded as certain.

Another interesting phenomenon is the frequent artistic representation of reclining or erect ibexes in the Bronze Age cultures of Turkmenia and Bactria. They are most common as decorations on metal pins which were used as cosmetic utensils or hair and garment pins. The seated animals are shaped in an almost identical posture as the stone images, sitting on a tiny base and turning their heads to the right. The same kind of metal pins have been known for a long time from Near Eastern sites such as e. g. Kish, Chagar-Bazar and the Susiana plain, and again a hiatus of approx. 1000 years between them and the Bactrian specimens remains a puzzling problem.

Moreover, protomes of mountain goats frequently adorn cosmetic bottles rescued from Bactrian graves and standing or reclining animals of the same type

were a very popular motif in Bactrian glyptic art, all dated around 2000 B.C.. Although the appearance of the mountain goat on cosmetic utensils might be an indicator for a purely decorative significance<sup>47</sup> of this animal, its frequent occurrence on the seals also makes a symbolic connotation possible.

Against the background of the knowledge we have of the Indo-Bactrian connection, it is very likely that the image of the ibex or mountain goat had a similar ideological meaning in both of the cultural entities, and that this phenomenon was finally a result of the complex relationships between the civilizations from the Arabian peninsular to the subcontinent from centuries ago.

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## Footnotes

- 1 Courtesy of the Department of Archaeology and Museums, Government of Pakistan, Karachi
- 2 Eleven of these fragments belong to a certain type of anthropomorphic statue, namely HR 163, HR 910, HR 5785, L 898, L 127, SD 624, SD 2781, DK 1909, DK 4647, DK 1419, DK-B 1057 (see: *Ardeleanu-Jansen* 1984: 139-157) while five other fragments represent zoomorphic sculptures: VS 116, HR 1072, SD 1109, SD 2722, and U 81 036.
- 3 *Ardeleanu-Jansen* 1984: 154
- 4 *Ardeleanu-Jansen* 1984: 154, Fig. 40
- 5 *Deshayes* 1977: 104-5; *Amiet* 1983: 26; *Pottier* 1984: 73-74
- 6 *Amiet* 1983: 26; *Amiet* 1986: 203-204
- 7 *Pottier* 1984: 73-74
- 8 see FN 6
- 9 *Amiet* 1986: 203; *Ardeleanu-Jansen* 1987: 176. Although Amiet's interpretation argues from a different notion, he comes to the conclusion that the small squatting chlorite statue found at Susa (*Amiet* 1986: fig. 108) shows strong iconographic similarities to the male persons represented on the above mentioned Bactrian silver vessel and to one human stone sculpture from Mohenjo-Daro (L 950, *Marshall* 1931: Pl. C, 1-3). His observations might be taken as a support for my conviction that the human full length statues from Mohenjo-Daro have to be seen in relation to the Bactrian representations.
- 10 *Jarrige, J.-F.* 1987: 109-111
- 11 A stone image of a reclining animal has been found at Kalibangan. It is also headless and from the yet unpublished photograph it is not ascertainable whether this image belongs to the same category of sculptures under discussion.
- 12 The fragmentary cattle image found on the "citadel" at Mohenjo-Daro (SD 2722, *Mackay* 1938: Pl. LXXI, 25) does not belong to this group of sculptures under discussion. It has been dealt with previously, I refer to my contribution "A Short Note on a Steatite Sculpture Fragment from Mohenjo-Daro" for SAA 1985, in: *K. Frifelt* (ed.), Aarhus, in press
- 13 E. g. *Marshall* 1931: 360; *Mode* 1944: 64; *Wheeler* 1968: 88; *Fairservis* 1975: 285; *Allchin & Allchin* 1982: 204; *Pittman* 1984: 88; *During-Caspers* 1976; *During-Caspers* 1986: 302
- 14 See supra: entry in Vats' diary from 10-12-1925
- 15 For SD 1109 see ARASI 1925-25: 80, and *Marshall* 1931: 150; for HR 1072 see ARASI 1925-26: 85 "White limestone pedestal with an image of seated composite animal. Head broken. The image is similar to the one found in SD area (compare page 80 above). It has the body of a bull, the head of a ram and the trunk of an elephant." and *Marshall* 1931: 181, 360.
- 16 Similar fantasy creatures were published in the second monograph on Mohenjo-Daro by *Mackay* 1938: Pl. LXXXVII, 258 = DK 12194; Pl. XCIV, 411 = DK 5307; Pl. XCV, 450 = DK 6658; Pl. XCVI, 493 = DK 8248 or DK 8253; Pl. XCVI, 521 = DK 5935; Pl. CVIII, 636 = DK 8519.
- 17 Already hinted at by *During-Caspers*. (*During-Caspers* 1986: 302)
- 18 Possibly a tiger? See *Marshall* 1931: 389
- 19 "... certain details appear common to all three pieces of statuary." (*During-Caspers* 1985: 423)
- 20 *Marshall* in ARASI 1925-25: 80, 85; *Mackay* in *Marshall* 1931: 360; *Mode* 1944: 64; *Wheeler* 1968: 88; *Allchin, B. & F. R.* 1982: 204
- 21 *Fairservis* 1975: 285; *During-Caspers* 1986: 302; *Pittman* 1984: 88
- 22 *Marshall* in ARASI 1925-26: 80; *Mackay* in *Marshall* 1931: 360; *Mode* 1944: 64; *Wheeler* 1968: 88; *Allchin, B. & F. R.* 1982: 204
- 23 The stone image was discovered by M. Uebecke, then member of the "German Research Project Mohenjo-Daro" mission to Mohenjo-Daro, in the southern area of VS A.
- 24 This typical rendering of the ears was actually misunderstood by E. *During-Caspers* when she discussed the figure SD 1109 and contemplated whether this "small dependent loop" should be regarded as an eye. Although she deemed that it was too "wrongly shaped and angled for a natural eye", her supposition that "it appears too small and ill-situated to represent an ear" (*During-Caspers* 1985: 425) can now be rejected, as it is obviously meant to represent the ear of sculpture 81 U 036.
- 25 Personal communication with R. H. Meadow
- 26 *Roberts* 1977: 190
- 27 VS 116 is approx. 17,8 cms high and 33 cms long while 81 U 036 is in its present condition ca. 16,5 cms high and ca. 20 cms long, indicating that it originally must have had approx. the same length as VS 116.
- 28 Courtesy of the Department of Archaeology and Museums, Government of Pakistan, Karachi, and the Archaeological Survey of India, New Delhi.
- 29 The whereabouts of the original image could, up to the present day, not be traced by authoress.
- 30 According to Pittman's information "recently acquired from an old American collection" ... (*Pittman* 1984: 88)
- 31 PKG Bd. 13, 1974: Abb. 68a-c
- 32 I am indebted to Paul Yule, Bonn, who drew my attention to Mrs. Pittman's publication.
- 33 According to Pittman "the Mohenjo Daro pieces" are "fine examples of ancient Near Eastern sculpture." (*Pittman* 1984: 88)
- 34 *Behm-Blanke* 1979: 17, Nr. 100, Abb. 27a-c (Ag 35: 880)
- 35 *Behm-Blanke* 1979: 18, Nr. 107, Taf. 9, 50a,b (Sb 110)

- 36 Some rare examples are worked in bronze, compare Mackay 1938: Pl. LXXVII, 15 = DK 4091
- 37 An observation already made by M. S. Vats (Vats 1940: 305) and H. Pittman (Pittman 1984: 99 FN 14). The published examples are to be found in: Marshall 1931: Pl. XCVII, 1 = HR 2013; 2 = SD 2278; 3 = VS 2046; 5 = SD 2278; Mackay 1938: Pl. LXXIV, 6 = DK 11 229; Pl. LXXVII, 8 = DK 10 303; 9 = DK 12 858; 13 = DK 4566; 15 = DK 4091; and Vats 1940: Pl. LXXVIII, 42 = 8766; 43; 44 = Ab616; 45 = 11458
- 38 DK 10 781 AC (Mackay 1938: Pl. LXXIV, 18-19)
- 39 According to the excavators' descriptions VS 116 was found at 2 feet below surface in a context called "Intermediate", HR 1057 came from -2 feet in House III in HR-A area designated as a structure of the "Intermediate" period and SD 1109 lay at 3 feet below the surface in an area dated "Late". (Marshall 1931: 360) 81 U 036, finally, was recovered from the surface in VS-A area.
- 40 Ardeleanu-Jansen 1984: 154
- 41 see FN 29
- 42 E. g. the lion-bull combat, referring to the celestial constellation of Leo and Taurus, "had originally an astronomical meaning and symbolized a well-defined calendrical event (a solar date);" (Hartner 1965: 3)
- 43 From the beginning of the third millenium B.C. up to the first millenium B.C..
- 44 Our contemporary zodiacal constellations are based on helenistic traditions which go back to Seleucid texts referring to much older observations mentioned in the "mul Apin" series of Babylonian times.
- 45 Marshall 1931: 75; Miller 1985: 50; Jansen 1987: 155
- 46 See Maula 1984 in: Jansen/Urban (eds.) Interim Reports Vol. I: 159-170 and Wanzke this volume.
- 47 Sarianidi 1986: 183

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**Fig. 1**



**Fig. 3**

**Fig. 1** VS 116 (Museum: unknown) H.: ca. 17,8 cm; L.: ca. 33 cm  
(photo: Sind Volume IX 1925-26, 3665)

**Fig. 2** SD 1109 (MM\* 430) H.: 25,5 cm; L.: 19,5 cm; B.: 13 cm  
(photo: Georg Helmes, Aachen)

**Fig. 3** HR 1072 (Museum: unknown) H.: ca. 21,3 cm;  
L.: ca. 16,3 cm; B.: ca. 10,2 cm  
(photo: Sind Volume VIII 1925-26, 339)

**Fig. 4** U 81 036 (MM\* 5695) H.: 16,5 cm; L.: 22 cm; B.: 12,3 cm  
(photo: Georg Helmes, Aachen)



**Fig. 2**

**Fig. 4**





Fig. 5



Fig. 6

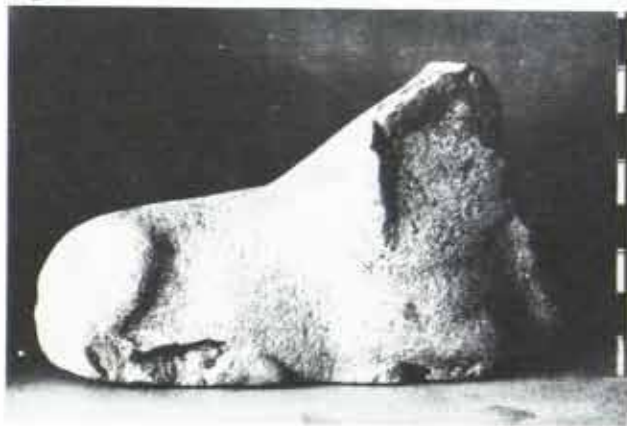


Fig. 7



Fig. 8

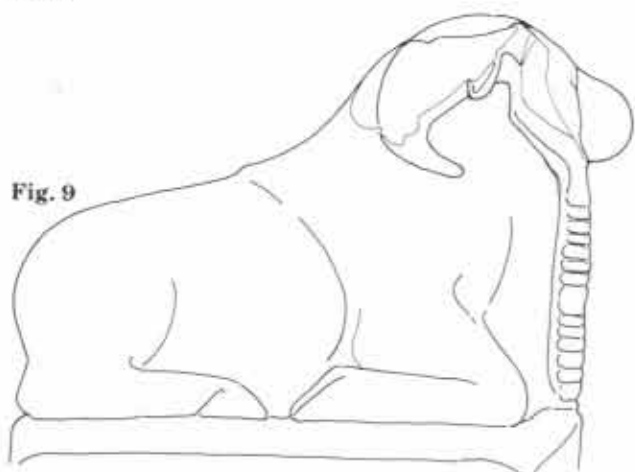


Fig. 9

Fig. 5 U 81 036 (MM\* 5695)

Fig. 6 SD 1109 (MM\* 430) (photo: Georg Helmes, Aachen)

Fig. 7 VS 116 (Museum: unknown) (photo: Sind Volume VII 1925-26, 281)

Fig. 8 DK 4865 (NMK\* 52.3205) H.: 1,6 cm; L.: 2,5 cm; B.: 1,1 cm (photo: Georg Helmes, Aachen)

Fig. 9 SD 1109 (MM\* 430) (drawing: Rolf Bunse, Aachen)

\* MM = Mohenjo-Daro Museum

\* NMK = National Museum, Karachi

## A New Copper Tablet from Mohenjo-daro (DK 11307)\*

Paul Yule,  
Bochum

To the incunabula of the Harappan script belongs a hitherto unrecognized depiction scratched into a rectangular reddish "copper" tablet on deposit in the Study Collection of the Archaeological Survey of India in Delhi (Fig. 1). Despite its striking character, this representation has been neglected by specialists generally preoccupied with the problems of decipherment. For whatever reason, the tablet did not appear in E. J. H. Mackay's excavation report of 1938 for Mohenjo-daro, from where it was excavated in 1931. Rather, it remained almost unnoticed until B. M. Pande sketched it for preliminary publication in 1973.<sup>1</sup>

The exact findspot of the tablet is problematic. On its reverse side, the excavation number and inventory

number of the Purana Qila Study Collection (SC 63.10/262) appear in white paint. According to the fieldbook of the excavation, the tablet came to light in room 327 of the DK-G area<sup>2</sup>, and lay at a depth of 2.68 m below datum, which the excavator assigned to his Late Period II. But neither the block, house, nor the room of the preliminary numbered room 327 are identifiable in the final plan. Thus, the location and nature of the find context remain obscure. Nor are the associated finds of help in determining the original use of the architectural structure or of the tablet itself.<sup>3</sup>

As often the case with such tablets, the surface of the metal has suffered from abrasive cleaning. Following the restoration, chalk was rubbed into the incisions in order to make the motif more readily visible. On the obverse the position of the hooves, legs and the drawing of the shoulders leave little doubt as to the iconography. Two front halves of conjoined bovids point respectively to the left and right. Moreover, flanking this phantastic creature are two "altars"<sup>4</sup> which otherwise only appear in front of the creatures depicted on Harappan seals and copper tablets. The right head is well-preserved. Visible are horns, ears, and vertical stripes, as in the case of the unicorns which appear on Harappan sealstones.<sup>5</sup> The head on the left is badly damaged, but visible are a horn, the lower contour of the jaw and vertical stripes across the face, similar to those of the head right. The appearance of this motif becomes clearer when held in the hand than is evident from even excellent photographs. Clearly we are not dealing with a recut tablet; other depictions on copper tablets also show creatures with heads in front in the normal position, and emerging from behind as well.<sup>6</sup>

The reverse is more difficult to make out than the obverse, but the four signs are intact and legible, although at certain points only as slight imprints.

The inscription associated on copper tablets with a different kind of bull, the short-horned bull<sup>7</sup>, differs from our inscription, and we may be dealing with two different deities, each having its own name.

A. Parpola has remarked that the figural representation suggests a dichotomy such as day and night, or summer and winter, in order to explain the iconology.<sup>8</sup>

In fact, the double animal motif is by no means unique to the Harappan Culture, but also occurs in neighbouring areas.<sup>9</sup>

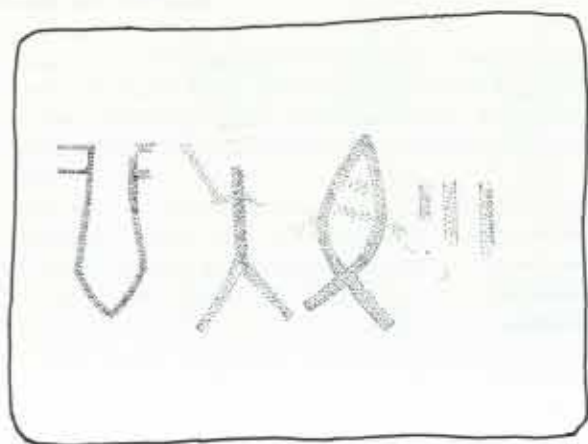
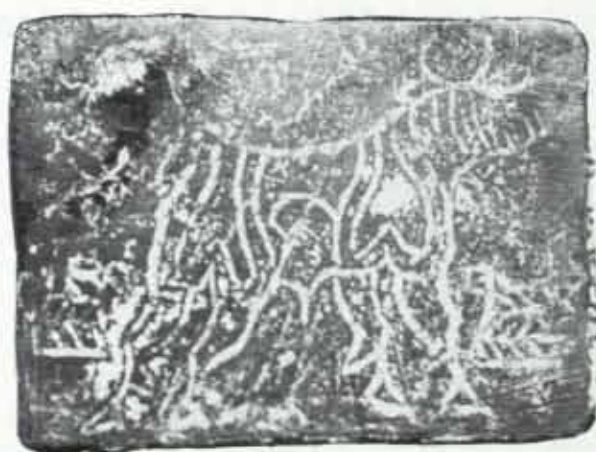
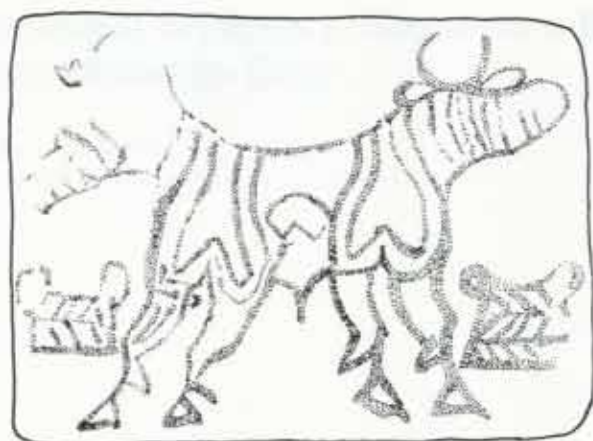
From a recent recording and study of all Harappan copper tablets (142 reasonably preserved examples), the piece under discussion shows a new pictorial type. It is one of a number of unpublished metallic artifacts which demonstrate that the extant Harappan objects are less stereotyped and repetitive than one might surmise on the basis of the *prima facie* materials from Chanhudaro, Harappa, Mohenjo-daro and other sites.

# Footnotes

\* I should like to thank Dr. Debala Mitra, Director General of the Archaeological Survey of India at the time of my campaign in 1982, for permission to record and publish the tablet presented here, and for supporting our Corpus of Prehistoric South Asian Metal Objects.

Shri R. P. Sharma, at the Study Collection, was particularly helpful. The tablet under consideration measures 3.86 x 2.87 x 0.22 cm. Few Harappan metal artifacts have been analyzed in order to determine their constituent elements (no tablets have been analyzed), but the material of our piece is probably copper, at least to judge from the colour. Although there is room for doubt as to the metal, I retain the term "copper" for reasons of economy. With regard to the identification of copper and bronze see Yule, *Harappazeitliche Metallgefäße in Pakistan und Nordwestindien. Prähistorische Bronzefunde II*, 7 (Munich 1985) 22-23 note 17 (= PBF). Lastly, Prof. Asko Parpola kindly criticized the text.

- 1 S. Koskeniemi/S. Parpola/A. Parpola, *Materials for the Study of the Indus Script* (Helsinki 1973) inscription number 030272042. B. M. Pande, "Inscribed Copper Tablets from Mohenjo-daro: A Preliminary Analysis." D. Agrawal/A. Ghosh (eds.), *Radiocarbon and Indian Archaeology* (Bombay 1973) tablet no. 38. Pande verifies the museum inventory number with the excavation number. Cf. Yule, *Figuren, Schmuckformen und Täfelchen der Harappa-Kultur. PBF I*, 6 (Munich 1985, 4, no. 47, 415.)
- 2 I thank Alexandra Ardeleanu-Jansen for this information (letter 14.05.85). Further work on the reconstruction of the excavation and finds by her may clarify the provenance.
- 3 An alabaster dish (DK 11306) was the only other object accompanying the tablet. (ibid.)
- 4 Pande's sketch (supra note 1) is very cursory. It omits all details, the "altar", and the traces of the head on the left, the ears on the head on the right, to mention the most obvious exclusions.
- 5 Cf. Sir John Marshall, *Mohenjo-Daro and the Indus Civilization* (London 1931) Pl. CIII; Sir Mortimer Wheeler, *The Indus Civilization* (Cambridge 1968) Pl. 27.
- 6 Cf. Yule, *PBF I*, 6 nos. 460-466, 469.
- 7 The Finnish team has equated our bicorporate with the short-horned bull. S. Koskeniemi/S. Parpola/A. Parpola, *Materials for the Study of the Indus Script*; A. Parpola, "Tasks, Methods and Results in the Study of the Indus Script." *JourRoyAsSoc* 1975, 2, 197. Short-horned bulls: Yule, *PBF I*, 6 Nos. 412 and 413.
- 8 Personal communication.
- 9 Cf. R. von Heine-Geldern, "New Light on the Aryan Migration to India" (1937). R. von Heine-Geldern *gesammelte Schriften. Acta Ethnologia et Linguistica* (Vienna 1983) 155-167 fig. 5a-c: from T. Hissar IIIC, Kedabeg Kalakent (Early Iron Age), and from Transcaucasia (no context); P. Amiet, *Collection David-Weill. Les antiquités du Luristan* (Paris 1976) 67-68 fig. 43, no. 138. I thank M. Bemmman for these citations. Cf. also K. Pischelauri, *Jungbronzezeitliche bis ältereisenzeitliche Heiligtümer in Ost-Georgien. AVA Materialien 12* (Munich 1984) 54 fig. 30, 15-29 from Silda (2nd half of the 2nd mill.).



DK 11307

Fig. 1 "Copper" tablet DK 11307 (SC 63.10/262).



# Chemical Analysis of Stoneware Bangles and Related Material from Mohenjo-Daro

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## Materials and Methods

This paper presents preliminary results of a study of stoneware bangles from Mohenjo-Daro (Franke 1984), their raw materials and manufacturing technique and their relationship to other ceramic materials from this site.

Starting with the investigation of a single fragment of a stoneware bangle from Mohenjo-Daro (Schneider/Büsch 1984), 28 new samples were analysed for a more generalized view (Table 1). The new series included fragments of bangles with oval, irregular triangular and round cross-sections and of varying colour, samples from coated sub-cylindrical bowls which were probably used in the manufacture of the bangles (Halim/Vidale 1984: 93), other samples from coated carinated jars, from potsherds and from a terracotta fragment from Mohenjo-Daro. A clay sample from a recent potter's workshop in a village nearby was analysed for comparison purposes. The investigation was conducted in cooperation with Ute Franke and the German Research Project Mohenjo-Daro.

The analyses were carried out by wavelength dispersive x-ray fluorescence (Philips PW 1400). One gram of a powdered sample is mixed with four grams of a flux (Merck Spectromelt A 12) and melted to produce a glass disc for automatic measurement. The calibration is based on forty international geochemical standards and on interlaboratory tests for pottery analysis. The elemental compositions (Table 2) are given on a basis of ignited samples (950° C) for easier comparison.

## Results

The composition of the analysed bangles shows only very little variation. It corresponds to a calcareous clay with a high amount of flux: iron, calcium, potassium and sodium.

There is no indication of any admixture of other materials (e.g. iron oxides, feldspar) as is shown by comparison with the composition of clay samples

(Table 2: 2953, 3297). There is no essential difference in composition between bangles of different shape or firing conditions, if the valence state of iron is not taken into consideration. That means that the same raw materials were used. The potassium and rubidium values of the oval-type bangles are a little bit higher than those of the round-type bangles. This can only be recognized due to the extreme homogeneity of composition of these groups and could be interpreted as an indication of a slightly different clay source. However, more samples are needed to prove this difference.

Some bangles contain significantly higher amounts of sodium. Three of these are red unpainted bangles with round cross-sections. They are more similar in composition to the pottery group. The higher ignition losses of the bangles with higher sodium content could be an indication of secondary compositional changes due to contamination in the ground. This is supported by the fact that the samples with the highest ignition losses have significant amounts of sulphur up to 0.5% (in 2949). If this was added as sodium sulphate it would result in a Na<sub>2</sub>O value which is higher by 1%. The modern clay sample contains about 0.1% sulphur, whereas all other materials show only traces.

Coated sub-cylindrical bowls, coated carinated jars, pottery and terracotta from Mohenjo-Daro analysed are similar in material composition to the bangles and are very probably made from a clay of the same origin. Minor differences in calcium content allow a grouping of these materials. Because of the small number of samples such groupings are only preliminary and remain to be proved by new analyses of more samples.

One sample of a coated sub-cylindrical bowl (2940) has a composition identical to that of the bangles. A second sample (2941), however, is different through higher amounts of calcium (and strontium) and lower amounts of potassium, aluminium and iron which could be explained as due to a less fine levigation of the original clay. The analyses of coated carinated jars represent a different compositional group containing less calcium (iron, manganese, magnesium and strontium) and higher amounts of silica, sodium (and zirconium). A sample of a pointed-base goblet (2942) as well as two potsherds and a terracotta fragment are very similar to the latter group. This group of pottery, terracotta, coated carinated jars and the simple round-shaped bangles, in contrast to the composition of the majority of the bangles, has a much larger compositional variation. This could be explained by a less thorough preparation of the raw materials.

By comparison with the modern potter's clay (2953) and the alluvial sediment (3297) which are very similar

in their main and trace element composition, it can be shown that the raw materials were available in the Mohenjo-Daro region. This conclusion is supported by five previous analyses of bricks (Ludwig 1983: 156) and vitrified kiln materials (Gussone 1983: 168) which show a similar composition and very likely were also made from local clays. Microscopic studies of thin sections confirm the results obtained from chemical analysis. The material used for the bangles was levigated very finely and, with a few exceptions, does not contain grains larger than about 20  $\mu$ , whereas the other materials include grains of quartz and feldspar (plagioclase) up to 60  $\mu$  (and sometimes larger). This is also true for the clay used by the potters in Hassan Wahan, which is suitable for reconstruction experiments because of its mineralogical and chemical similarity.

Ignition losses of the bangles and pottery samples are generally low, indicating high original firing temperatures. Because of an initial firing in a reducing atmosphere ignition losses can even be negative due to the oxidation of Fe(II) to Fe(III). As a result of this oxidation the weight increases by about 0.8% and thus reduces the decrease which is caused by the evaporation of water. This is true for the grey samples whereas the red materials were fired in an oxidizing atmosphere. Firing in an oxidizing atmosphere results in a lower degree of vitrification even when the same temperature is applied, due to the Fe(III) which is not as good a flux as Fe(II). This is evident from the examination of round-shaped bangles in the scanning electron microscope showing increasing stages of vitrification (Fig. 1 to 4). A red-coloured bangle represents the lowest vitrification stage. Pale brown mottled surfaces derive from a later oxidizing of Fe(II) due to corrosion. This weathering layer can also be seen on broken surfaces of bangle fragments.

The water-absorbing capacity of fragments is less than 1.5%. Therefore this material is classified as a stoneware. It is higher only in red-coloured bangles with round-cross sections. Hardness of the grey bangles is between Mohs 6 and 7. The material is thus harder than steel or glass.

The technologically outstanding ceramic material is very similar to the so-called "Böttgersteinzeug". This

was invented about 1709 A.D. in the course of trying to produce porcelain in Europe. Because of its hardness and its fine texture it can be ground like semi-precious stones. The comparison of the Mohenjo-Daro bangles with an original sample of "Böttgersteinzeug" shows a textural correspondance under the microscope. The latter material also contains grains of quartz up to 20  $\mu$ , but in a larger amount and it shows a similar degree of vitrification. Since it is made from an uncalcerous clay (Table 2: 3249 and 3250) it needs a higher firing temperature.

## Conclusions

All stoneware bangles from Mohenjo-Daro investigated here were made from a very finely levigated clay which is similar in composition to a clay still used today by potters in a nearby village. This is true for bangles of different shapes and colours. The same material was used for coating sub-cylindrical bowls. The coated carinated jars as well as pottery and terracotta were also made from a very fine clay, but slightly different in composition. From this we may conclude that bangles and pottery were made in different workshops, because we would expect a higher dissimilarity between two materials prepared for different purposes in the same workshop.

The grey bangles were fired in a reducing atmosphere between 1000° and 1100°C. To do this the best way would have been firing in ceramic containers as described by Halim and Vidale 1984. The red-coloured bangles were fired in an oxidizing atmosphere, therefore this could not have been done in containers. These bangles are less vitrified. Further investigations into the method of manufacture are in progress.

From the point of view of the material's science the Mohenjo-Daro bangles represent a very advanced stage of ceramic technology. In Europe a similar material was reinvented about 4000 years later. Apart from a special kind of pottery from the first half of the 3rd millenium B.C. which is found in NE-Syria and SE-Turkey the stoneware bangles from Mohenjo-Daro represent the earliest known artefacts of real stoneware.

Table 1

List of investigated samples. The samples derive from private collections. Colours are given for freshly broken surfaces if not otherwise specified, symbols according to Munsell Soil Colour Chart.

Fragments of bangles with oval or irregular triangular cross-sections

1987	very dark grey (10YR3/1)
2930	dark grey (7.5YR4/1), surface colour pale brown (10YR6/3)
2931	dark grey
2932	grey
2933	grey
2934	dark grey, surface colour pale brown mottled
2935	dark grey, surface colour pale brown mottled
2936	dark grey, surface colour pale brown mottled
2937	dark greyish-brown (10YR4/2)

Fragments of bangles with round cross sections, painted

2943	grey, 15 mm thick, painted line reddish brown
2944	dark grey, 15 mm thick, painted line reddish brown
2945	grey, 10 mm thick, surface colour pale brown with reddish brown painted line
2946	very dark grey, 12 to 15 mm thick, irregular round, painted line dark brown
2947	yellowish red (5YR4/6 to 5/8), 15 mm thick, painted line dark reddish brown (2.5YR3/4)
3298	yellowish red, 16 mm thick, painted line dark reddish brown

Fragments of simple, rounded bangles

2948	yellowish red
2949	yellowish red
3299	yellowish red, 9 mm thick

Other materials from Mohenjo-Daro

2940	body fragment of a coated sub-cylindrical bowl, 4 to 5 mm thick, dark grey
2941	base fragment of a coated sub-cylindrical bowl, 4 mm thick, grey
2938	body fragment of a coated carinated jar, inner layer (a) and outer chaff-tempered layer (b)
2939	layered fragment of a coated carinated jar, 25 mm thick
2942	body fragment of an overfired pointed base goblet
2950	yellowish red coloured potsherd
3296	potsherd of black on red ware
2954	fragment of a terracotta
2953	unfired potsherds from a potter in Hassan Wahan
3297	alluvial sediment of the river Indus

Later material equivalents (from S. Bursche, Berlin)

3949	sample of original "Böttgersteinzeug" of 1710 A.D., dark reddish brown (2.5YR2.5/4)
3950	sample of modern "Böttgersteinzeug"

**Table 2**

Chemical composition of samples determined by X-ray fluorescence

Main element oxide content (% by wt.)

	SiO <sub>2</sub>	TiO <sub>2</sub>	Al <sub>2</sub> O <sub>3</sub>	Fe <sub>2</sub> O <sub>3</sub>	MnO	MgO	CaO	Na <sub>2</sub> O	K <sub>2</sub> O	P <sub>2</sub> O <sub>5</sub>	ign. loss	SUM*
1987	54.14	.903	18.64	8.14	.126	4.06	9.17	.97	3.43	.156	-.45	100.32
2930	54.09	.916	18.36	8.61	.142	3.99	9.41	.95	3.37	.156	-.50	95.51
2931	54.69	.907	19.13	8.49	.122	3.96	8.31	.81	3.42	.157	.02	98.90
2932	55.05	.903	19.37	8.30	.109	3.90	7.95	.80	3.46	.155	-.41	99.01
2933	54.47	.903	18.71	8.39	.155	3.93	8.78	.96	3.60	.152	-.39	98.99
2934	54.58	.903	18.93	8.45	.119	3.89	8.54	.88	3.56	.151	-.42	98.30
2935	54.45	.908	18.79	8.48	.125	4.09	8.76	.84	3.41	.151	-.47	99.01
2936	54.72	.903	19.22	8.50	.117	3.84	8.10	.87	3.58	.153	-.39	99.66
2937	54.26	.905	18.79	8.45	.120	3.77	8.58	1.58	3.36	.187	.71	98.50
2943	54.46	.907	19.10	8.55	.131	3.97	8.57	.91	3.26	.147	.49	99.37
2944	54.81	.914	18.67	8.47	.140	3.89	8.76	.88	3.31	.156	-.14	98.91
2945	54.71	.904	18.56	8.38	.131	4.06	8.82	.98	3.27	.156	-.31	98.96
2946	54.62	.903	19.05	8.51	.126	4.28	8.04	.98	3.35	.145	.02	98.15
2947	54.93	.905	19.07	8.49	.126	3.88	8.30	.99	3.14	.179	.90	99.09
3298	54.35	.910	19.82	8.66	.132	3.65	8.08	1.02	3.24	.153	0.97	100.40
2948	56.55	.897	18.57	8.26	.124	3.75	6.74	1.37	3.55	.180	1.03	98.64
2949	55.15	.862	18.19	7.99	.117	3.62	7.01	2.90	3.93	.221	2.29	98.24
3299	57.99	.844	18.17	7.69	.103	3.60	6.42	1.72	3.31	.210	2.38	99.41
2940	54.55	.908	18.57	8.38	.132	3.81	9.40	.88	3.22	.149	-.30	100.17
2941	57.76	.830	16.47	6.71	.115	4.34	10.69	.95	1.99	.155	.32	99.12
2938a	58.91	.876	18.60	8.03	.105	3.46	5.08	1.33	3.41	.198	.64	98.19
2938b	58.76	.866	18.45	7.91	.103	3.46	5.41	1.32	3.51	.219	1.53	99.82
2939	58.83	.874	18.40	7.94	.105	3.43	5.32	1.43	3.49	.184	.53	97.48
2942	58.68	.812	16.74	7.12	.102	3.71	7.61	1.59	3.27	.372	.23	98.45
2950	57.34	.807	15.89	6.89	.116	3.67	9.05	2.39	3.53	.211	2.58	97.44
2954	55.54	.832	17.41	7.55	.111	3.62	8.88	2.40	3.25	.405	1.59	97.86
3296	58.99	.852	18.77	7.76	.096	3.53	5.13	1.39	3.31	.179	1.36	99.63
2953	57.49	.835	16.80	7.26	.117	3.61	8.69	1.79	3.23	.178	9.96	99.94
3297	63.46	.727	14.45	5.46	.095	2.89	8.43	1.76	2.54	.176	7.89	98.81
3249	61.79	1.17	20.53	12.3	.032	.94	.55	.31	2.27	.151	.00	100.74
3250	61.51	.841	21.81	7.58	.199	1.15	1.36	.83	4.63	.093	.00	99.88

Trace elements (ppm, by wt.)

	V	Cr	Ni	Cu	Zn	Rb	Sr	Y	Zr	Ba	Ce
1987	162	140	73	49	116	191	255	31	152	551	75
2930	154	136	75	54	106	192	281	31	154	607	77
2931	155	142	83	48	120	193	263	29	148	521	90
2932	163	141	77	63	129	191	255	29	145	553	65
2933	165	137	78	56	124	193	255	29	149	519	74
2934	162	140	78	61	120	198	259	28	150	545	87
2935	159	138	77	54	115	191	270	29	147	531	73
2936	166	139	76	36	121	197	251	28	143	513	75
2937	166	141	75	54	115	182	254	28	145	559	80
2943	167	244	72	26	112	185	261	28	147	581	87
2944	164	139	77	27	111	180	258	28	148	597	87
2945	157	137	77	37	108	181	284	28	154	569	83
2946	163	140	76	46	114	188	277	29	150	610	72
2947	156	142	76	52	115	181	265	26	147	587	72
2948	134	138	73	46	107	180	262	27	150	614	78
2949	133	136	69	105	112	173	250	25	150	575	67
3298	133	143	76	52	130	178	278	26	150	589	86
3299	117	132	70	54	116	162	262	26	170	524	75
2940	159	135	76	35	112	175	260	28	149	570	86
2941	142	126	65	21	83	88	435	27	175	522	71
2938a	156	135	74	29	115	186	208	32	172	575	76
2938b	149	137	73	54	118	184	209	27	164	557	93
2939	152	140	74	43	125	196	208	30	166	564	76
2942	139	126	68	49	106	159	295	28	173	523	71
2950	127	121	60	43	93	158	378	28	171	539	68
2954	125	129	67	41	102	137	287	29	151	550	76
3296	140	139	76	44	108	168	292	25	168	552	92
2953	141	123	63	48	98	172	254	27	167	563	70
3297	107	100	44	35	75	127	244	28	212	468	76
3249		14	34			120	104		234	383	
3250		10	36			193	86		161	270	

\* (Original sum of measured concentrations. In order to minimize the analytical errors the analyses are normalized so that the sum of the main elements becomes 100 %)

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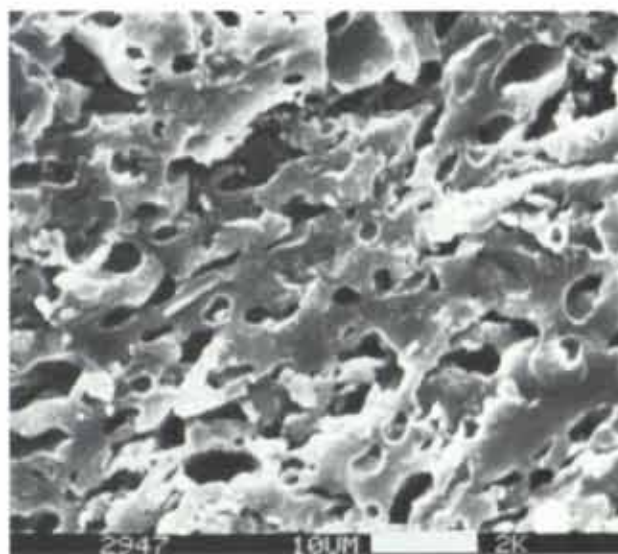


Fig. 1

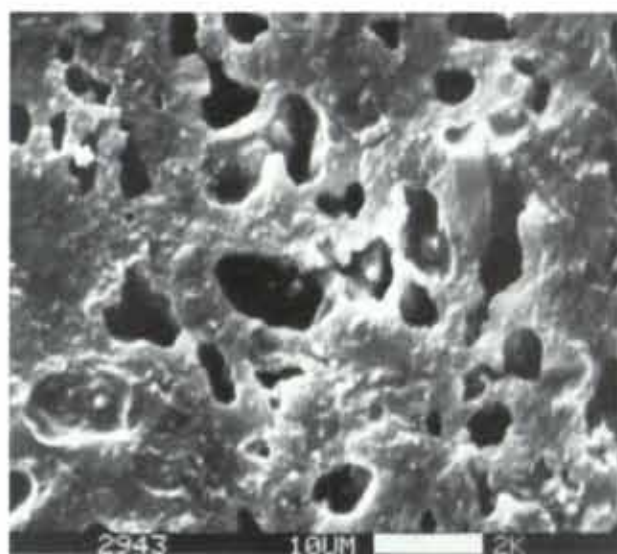


Fig. 2

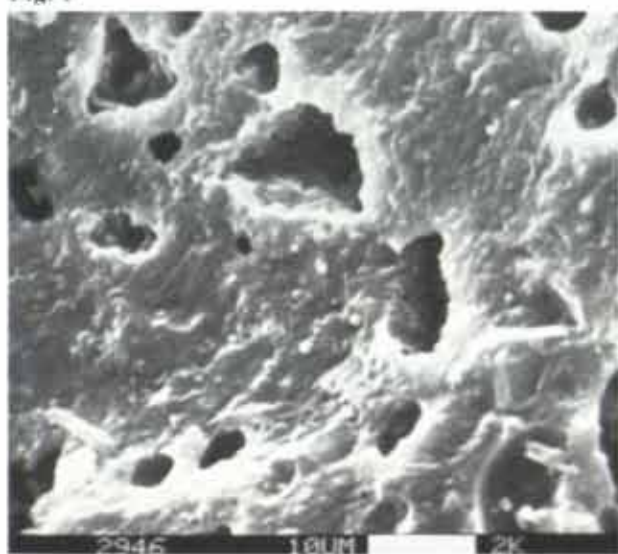


Fig. 3

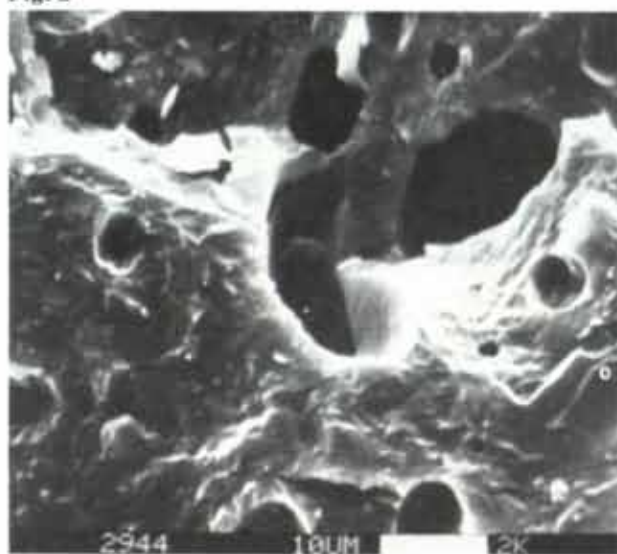


Fig. 4

**Fig. 1** Scanning electron microscopic image of a broken surface of a red bangle fragment (2947)

**Fig. 2** Scanning electron microscopic image of a broken surface of a grey bangle fragment (2943)

**Fig. 3** Scanning electron microscopic image of a broken surface of a dark grey bangle fragment (2946)

**Fig. 4** Scanning electron microscopic image of a broken surface of a grey bangle fragment (2944)



# A Model of Morphogenesis for Mohenjodaro

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## Introduction

The model proposed by Michael Jansen (see the article in this volume) wherein Mohenjodaro is envisaged as having risen initially on natural reliefs (terraces or mounds) in a more elevated position than the surrounding countryside and then as subsequently having expanded through the construction of mud-brick platforms, responds to some of the most important queries regarding Mohenjodaro as well as to a requisite of an ideological nature.

The queries are those already reported by M. Jansen in the above mentioned article:

- a deposit of pure silt at relatively high levels (traditionally interpreted as deposits brought about by flooding);
- the existence of ceramic fragments to a depth of up to 18 meters from the present surface level;
- the absence of fortifications;
- the existence of depressions;
- the prevalence of streets running north-south.

The requisite of an ideological nature is that of trying to find answers to the questions on Mohenjodaro without necessarily resorting to cataclysms and/or catastrophic events.

This type of approach could be considered rather unscientific and at any rate more of idealistic stand than one of a positivistic-experimental nature, but as we are dealing with a case like Mohenjodaro I believe that this stand is justified.

Many things, in fact, have been written on Mohenjodaro and in particular on the motives of its form and the possible causes of its demise.

Some scholars have preferred to give priority to the theory of exceptional natural causes such as catastrophic floods and/or tectonic movements that obliged the inhabitants of Mohenjodaro to undergo recurring destructive events up until the final destruction (*Raikes 1965, 1968, 1984; Dales 1983*). Others, however, have placed the accent more on human factors and economical process, ascribing greater importance to his intervention, seen as both constructive, erecting works to protect and control over natural events (*Jansen 1985*), and destructive, as he probably induced environmental deterioration through the incautious use of available resources (*Wheeler 1968; Fairervis 1961, 1984*). Others again have attempted a compromise with various, not necessarily catastrophic natural causes (*Lambrick 1967, 1973a, 1973b*).

Let us examine the form the problem took and the form it takes. Today Mohenjodaro presents the picture of a city that was abandoned at a particular point in time, from which a process of degradation and alteration began due to either natural causes (erosion etc.) or to the presence of man.

The matter at hand is to get to know the evolution and the pattern of this city (morphogenesis) — we know its final state, we do not know its initial steps, but we know certain aspects of its form in intermediary moments.

## The Theory of Models

Here is the complexity of the phenomenon to be studied and here appears, rather heavily, a situation of indeterminableness that makes modellization necessary, or rather, the necessity to derive a system to simulate the situation of departure through a certain analogy.

This process begins with the formulation of a question on the situation, we are faced with, which is transferred through the analogy onto the model which in turn is made to evolve in such a way as to provide an answer. By applying the analogy in the opposite direction, we obtain an answer to the situation observed that is then compared with the data of experience.

Penetrating further into the logic of models, these can be seen as being composed a priori, of two parts: One relative to the moment in which the parameters are assigned to the states of the process considered, the other dynamic, the description of the temporal evolution between the forms or between the states of the process (Thom 1980).

The case that we shall examine is quite particular in as much as it will deal with the construction of a model on the basis of historic, archaeological, geomorphological and geophysical data, that explains the morphogenesis of the protohistoric site and that is historically coherent with our knowledge of the Indus Civilization. The first part of the operation, the assigning of parameters, in our case, the gathering of data and, leaving aside for the moment the manner of gathering historic-archaeological data and the choice of both geomorphological and geophysical methods, this represents a fundamentally passive act.

The dynamic part of the model, however, has quite a different importance in the understanding of the phenomenon as it represents the description of the phenomenon's and/or the form's evolution through time.

This fact, in the case of local geophysical-geomorphological models that have to explain archaeological situation, is almost always described in qualitative terms and very rarely in quantitative ones. It is the researcher therefore, who intervenes with his/her qualitative judgement to describe the evolution of the phenomenon and the individual personality and psychology will weigh on the interpretation of this phenomenon.

This being so, the researcher has the added task of intellectual self surveillance, self analysis so as to be able to recognize how much one's culture, education and psychology influence the formulation of theory or, as in our case, the construction of models (Bachelard 1949).

## Mohenjodaro

The program of geophysical research at Mohenjodaro began with the aim of tracing the buried form of this protohistoric site in order to learn about its initial phases and form in relation to life on the Indus.

In the course of the years 1983 through to 1985 abundant data have been collected and some relevant results have been obtained (Cucarzi 1984, 1985; Zolese 1985).

Certainly we are not yet able to prove or disprove in a definite manner any of the hypotheses previously mentioned, but the degree of our knowledge of Mohenjodaro has certainly increased, even though a certain margin of uncertainty remains.

The ideological requisite mentioned at the beginning consists therefore, in an attempt to explain Mohenjodaro's patterned evolutionary process with a model that avoids bringing into play true catastrophic events and that sees man, rather than nature, as the protagonist, bearing in mind the normal conditions of the environment where Mohenjodaro is located: the flooding of the Indus and its meanderings in the course of centuries — without excluding that this obeys different hydrogeological parameters due to different climatic conditions (Singh 1974; Mishra 1984). With this assumption we deem it necessary to explore every possible reason in order to find explanations for this phenomenon in terms of a mild evolution. Catastrophic events remain greatly fascinating for the people, but from the scientific view point they can constitute the explanation of a phenomenon hurdling, in reality, a whole of events that lead to the same conclusion.

In doing this we are not hindering research on Mohenjodaro, we are merely proposing an interpretative model, of which the principal characteristic is flexibility (Bellone 1973) without prejudicing in any way the final nature of the reality, but leaving open a further solution that can be largely integrated into a global structure, but still leaving the possibility to interpret the same phenomenon in different ways.

## The Jansen Hypothesis

M. Jansen departs from the assertion that the Indus Civilization was constituted of a population with a riverine culture and, in the case of Mohenjodaro, of a population that knew the Indus and its behaviour. This population therefore lived with the river and not against it (Jansen 1986).

With this assumption in mind, he hypothesized that the settlement's first nucleus was on an elevated tract of clayey terrain that would have afforded defence against the seasonal flooding of the Indus. With the increasing need to occupy more space, the inhabitants of Mohenjodaro began to construct clay platforms to raise the level of the settlement area. In order to do this they extracted primary materials from adjacent zones and thereby created depressions in the terrain.

To sustain his model M. Jansen takes into account that these certain data exist:

1. The constructions at the greatest depth, surveyed in previous excavations are at 44 m a.s.l.;
2. The finds of fired bricks and ceramic fragments are at 36 m a.s.l. (from Nedeco etc.).

Jansen's thesis therefore, is that Mohenjodaro represents the moment in which the urban phase explodes in the Indus Civilization and, that in order to build Mohenjodaro they constructed gigantic clay and/or mud brick platforms to raise its base level, mainly to protect themselves from the recurrent flooding of the Indus. They extracted the primary material from adjacent zones thereby creating valleys that represented the physical limits of the city as well as forms of defence.

#### New Geophysical and Stratigraphical Data

During the 1983, 1984, 1985 campaigns numerous geophysical investigations were carried out within the overall program of geophysical exploration at Mohenjodaro.

Up to the present moment, measurements have been taken on magnetic susceptibility, the intensity of the magnetic field, horizontal electric profiles as well as vertical electric soundings. Furthermore, numerous stratigraphical samplings have been made to a depth of 3 meters and three perforations up to 20 meters. Research has been concentrated fundamentally in three zones (Fig. 1):

1. HR south depression;
2. HR north depression;
3. Citadel depression between SD and VS.

Through the measurements of the magnetic field in the southern zone of HR, it has been possible to evidence the existence of a horizontal clay/fired brick interface, 800 meters long and orientated east/west 2° north (Fig. 2).

This interface was then tested with a series of stratigraphical samplings up to a depth of 3 meters that revealed, on average, a situation like that in Fig. 3.

Facing mound M36 (Fig. 3) 3 meters from the remains of a wall that runs parallel to the depression (east-west direction), a bore (BC1) was sunk 19 meters deep that revealed a lithologic log as in Fig. 4. The vertical electric sounding VES 21 reveals that towards the center of the depression, 17 meters from mound M36 the depth of the anthropic deposit reaches 10/11 meters b.g.l., confirming both the data offered by the wave analysis of magnetic anomaly (Fig. 5) and that offered by Dales' boring (Dales 1983) carried out 30 meters towards west opposite area D.

What does this interface line represent?

In our opinion, there are three possible explanations:

1. The remains of an ancient bank of the Indus or one of its canals in existence before the settlement, existing at the same time as the settlement and active or not for a certain period; subsequent to the settlement and later disactivated.
2. Part of an ancient branch of the Indus, or one of its canals modified by man with rectifying operations.
3. A work constructed entirely by man.

#### HR NORTH DEPRESSION

In the north depression of HR numerous magnetic profiles in a north-south direction have been carried out as well as a long profile of 250 meters in a north-south direction crossing both the north depression, the area with structures of HR and the south depression (Figs. 3, 6).

None of these revealed the presence of anomalies similar to those encountered in HR south and in any case, the situation seems to be notably different from HR south. Anomalies in the intensity of the magnetic field evidence mild changes in the horizontal sequence of the layers.

A boring operation (BC2) was also carried out on a mud-brick wall, visible on the surface (photo 1).

After a layer of 5.30 m. of mud-brick and clay, the equipment we had at our disposal was not able to perforate a level of fired bricks.

#### THE DEPRESSION BETWEEN THE CITADEL AND VS

In the depression existing between the Citadel and VS two long magnetic profiles (250 meters) were carried out with an approximately east-west (Fig. 7) orientation.

Both reveal the existence of two clearly evident anomalies, one on the east margin and the other to the west of the profiles, while the course between these two points is exceptionally regular (Fig. 8). This is to be interpreted that in the tract of depression crossed by the profiles there are no buried fired brick structures as fired brick emerges quite quickly.

The wave analysis for anomalies does not reveal many similarities with that encountered in HR south except for a short tract near VS, even if the increase in field values occurs with a lower gradient.

VES 20, carried out at 80 meters west of the VS structures which (Fig. 9) confirms the absence of buried levels of structures in fired brick (Cucarzi, in press).

#### INTERPRETATION OF DATA

Let us recapitulate quickly on the data we have and that will be born in mind in constructing an interpretative model.

1. All the data from previous excavations that substantially indicate structures ascertained up to 44 m. a.s.l..
2. Borings carried out by Nedeco (1966) in the Old Site that reveal the presence of remains in fired brick and ceramic up to -18 b.g.l. (31 m. a.s.l.).
3. Borings carried out by WAPDA on the borders of the site that indicatively confirm the Nedeco data.
4. Borings carried out by Dales in 1965 in HR south (bricks and pottery up to 12 b.g.l.).
5. Geophysical and stratigraphical data of the Italo-German Mission.

Let us begin to take into consideration the depression between the Citadel and the Lower Town and in particular the area included in the band between the magnetic profiles *MAG 54* and *MAG 55 Y* between SD and VS.

As already mentioned, the magnetic measurements (*MAG 45, 55*) and the geoelectric ones of *VES 20* have shown that in the band under examination, buried structures in fired brick are not present, while approaching in an easterly direction, the structures visible on the surface (*VS*), structures emerge rapidly. If we construct an east-west section with the data from the Nedeco borings in the Old Site: *E3, E2, E1, W1, W2* (with a direction approximately parallel to the magnetic profiles), we are able to note that the lowest level of the probable construction in fired brick exists at -15 b.g.l., resting on a 2-3 meter thick layer of clay which, in turn, goes down to the base layer of sand (*Fig. 10*).

Following the section in a westerly direction, the level of bricks, or brick/sand and clay (the anthropic layer) rises, diminishing in thickness, before coming to the point of test *W2* where it exists only between -2 to -6 meters b.g.l.

If we continue to the west, the geophysical data reveal that this level is rapidly reduced to zero (*VES 20*). *Fig. 10* bears the representation of this.

We are therefore able to think that the deepest structures in this area are at -15 b.g.l. with a depression zone of up to -18 b.g.l. on the sides of the tract of clay, and following the section, a model could be conceived that evolves according to expansion and raising by platforms and constructions in clay. The necessity for this is induced from subsequent overflowings of the river, witnessed by the presence of silt in the zone of contact with the artificial platforms in clay.

Let us move on now in HR onto the north-south profile that crosses HR/E and that comprehends both the north and the south depression (*Fig. 11*). The results of the boring *BC 2* can be explained as if at a level that finishes at -5.30 another has imposed itself, represented by the mudbrick platform that is also visible on the surface. This phase could be evidence of the expansion of the site by platforms towards the south.

Let us once again ask ourselves the question: what does the clay-filling interface line of the depression in HR south represent?

There are two crucial points to be borne in mind:

1. *BC 1* revealed up to -17 b.g.l. a sequence of clay and sand without the presence of pottery or brick fragments.
2. Both the conclusions drawn from the geophysical examinations and the results obtained from the borings executed by Dales in 1965, reveal layers of anthropic deposits up to -12 b.g.l.. The situation can therefore be represented as in *Fig. 11*.

It is possible therefore, that the interface line in the south depression of HR represents a situation that shows as follows: initially, there existed a tract of river (and/or canal) that, at a certain point in time, became no longer active and that was used by Mohenjodaro's inhabitants as a boundary area during the city's phases of expansion. When, through the continuous floodings of the Indus, this boundary no longer represented a secure embankment, they built a new stage of clay and mudbrick platforms on top of it in such a way that the site could expand without being submerged in these waters.

It is worthwhile bearing in mind that another possible cause of destruction and therefore of the necessity for isolation, could have been the rising of salt by capillarity, as is proved by its presence in buried fired bricks in ancient layers from the analysis by Dr. Udo Ludwig (*Ludwig 1984*).

As things stand we do not know if the tract of river was active or not during the whole inhabited phase of Mohenjodaro, or whether it became inactive before the rise of the city. In any case, there is considerable evidence indicating that this line represents a southern boundary for this protohistoric site.

The evidence may be summarized thus:

- The fact that neither the southern continuation of HR nor that of the First Street, nor that isolated by Dales in 1965, have been found yet;
- that all the wall remains one sees in HR south near the contact area of the un-excavated areas and the depression have an east-west course;
- that beyond the depression HR south incorporated buildings in an urbanistic order like the rest of the settlement are not noted.

### Interpretative Model

On the basis of what has been set out up to now, we have constructed a model on the morphogenesis of Mohenjodaro that envisages that at a particular time, that for us is  $t=0$  (but not necessarily the time of the earliest settlement which has not yet been verified) of its formation, a settlement -15 b.g.l. in the area to the east of SD.

For a period that is not yet able to be established, Mohenjodaro is cyclically invaded by the seasonal floods of the Indus up to the moment when the new constructing techniques appear, represented by the large clay or mud-brick platforms at Mundigak, Mehrgarh, Harappa, Kalibangan and Lothal (Casal 1961; Jarrige 1984; Vats 1940; Wheeler 1984; Thapar 1973; Rao 1979).

At this point, the site's configuration evolves with a horizontal expansion through the use of clay and mud-brick platforms, and constructions with material from the pottery industry and/or vitrified nodules.

The growth of the lower city continues; to the west of the boundaries approximately represented by the line L2 and south of those of line L1, the boundary of the bank of a supposed ancient river bed.

Outside of this area and the citadel, that presumably underwent a similar evolutionary process, it is conceivable that the area continued to be cyclically invaded by the seasonal floodings of the Indus.

## Conclusion

The model here presented is justified *a priori* because it is founded on the analogy between a series of data relative to it and data of the real situation. An *a posteriori* justification is given, however, by the comparison with experience, or rather the comparison of model's response with experimental data. The next geophysical and geoarchaeological campaigns to be conducted at Mohenjodaro will be characterized by this: *the experimental validation of the model*.

Even in the case of this model being verified, numerous queries would still be left to be explained, but these could, however, find their answers within the whole of the envisaged investigation.

One of the key points certainly is represented by the importance of an accumulation of 15 meters of anthropic deposit. This datum has been held as true, based on the results of the tests carried out by Nedeco in 1966, although they were not checked with subsequent drillings, but this is planned for the next program. If the layer thickness value is confirmed, an explanation will have to be found as the calculations made to date on the extent of the aggradation of the Indus with the present hydrogeological parameters does not allow a greater increase than two meters every thousand years.

The justifications for an almost double value could be found in terms of a set of different hydrogeological parameters due to a different climate and/or a greater number of tributaries flowing into the Indus (like the Bolan) and therefore a higher degree of aggradation.

Should size checks on the deposit lower the value, the model would be still valid, and with even more reason. Another key point in understanding the morphogenesis of Mohenjodaro and its function as regards life on the Indus is constituted by the validity of the hypothesis on the nature of the clay-fired brick interface line in the south depression of HR, together with the stratigraphic sequences in the two depressions.

It is therefore conceivable that the geophysical, sedimentological, geohydrological, geobotanical and palaeo-ecologic research envisaged by the program linked with archaeological surface investigations and urbanistic studies will be able to furnish a new set of data that can be used for the construction of a structurally stable model of the morphogenesis of Mohenjodaro.

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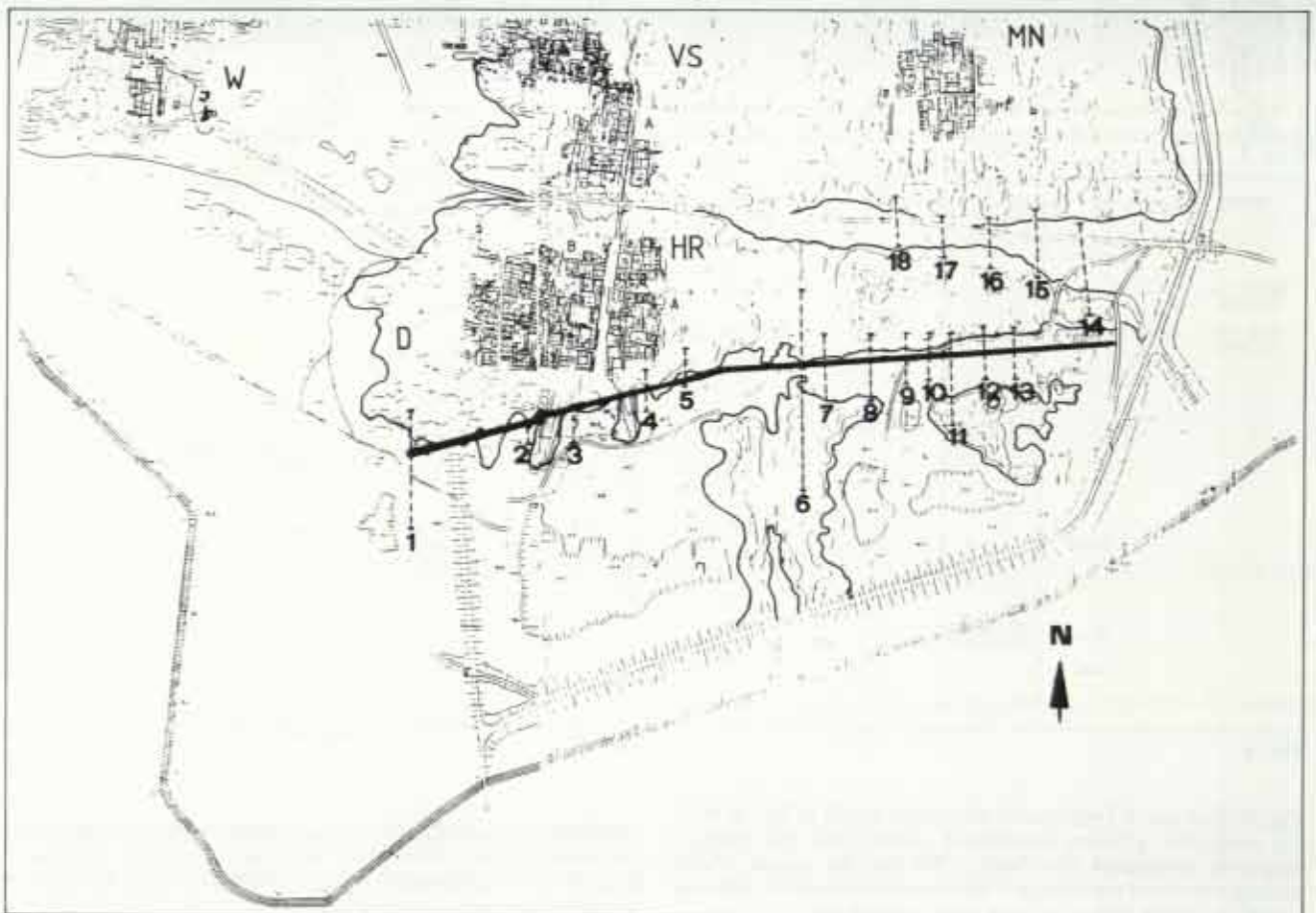


Fig. 1

**Fig. 1** General map of Mohenjodaro showing the four areas (1, 2, 3, 4) investigated with geophysical methods (dashed lines); New Site and Old Site are the points where Nedeco drillings were carried out in 1966.

**Fig. 2** Full line shows the position of the interface clay/bricks interpreted as clay or mud/brick platform.

Fig. 2



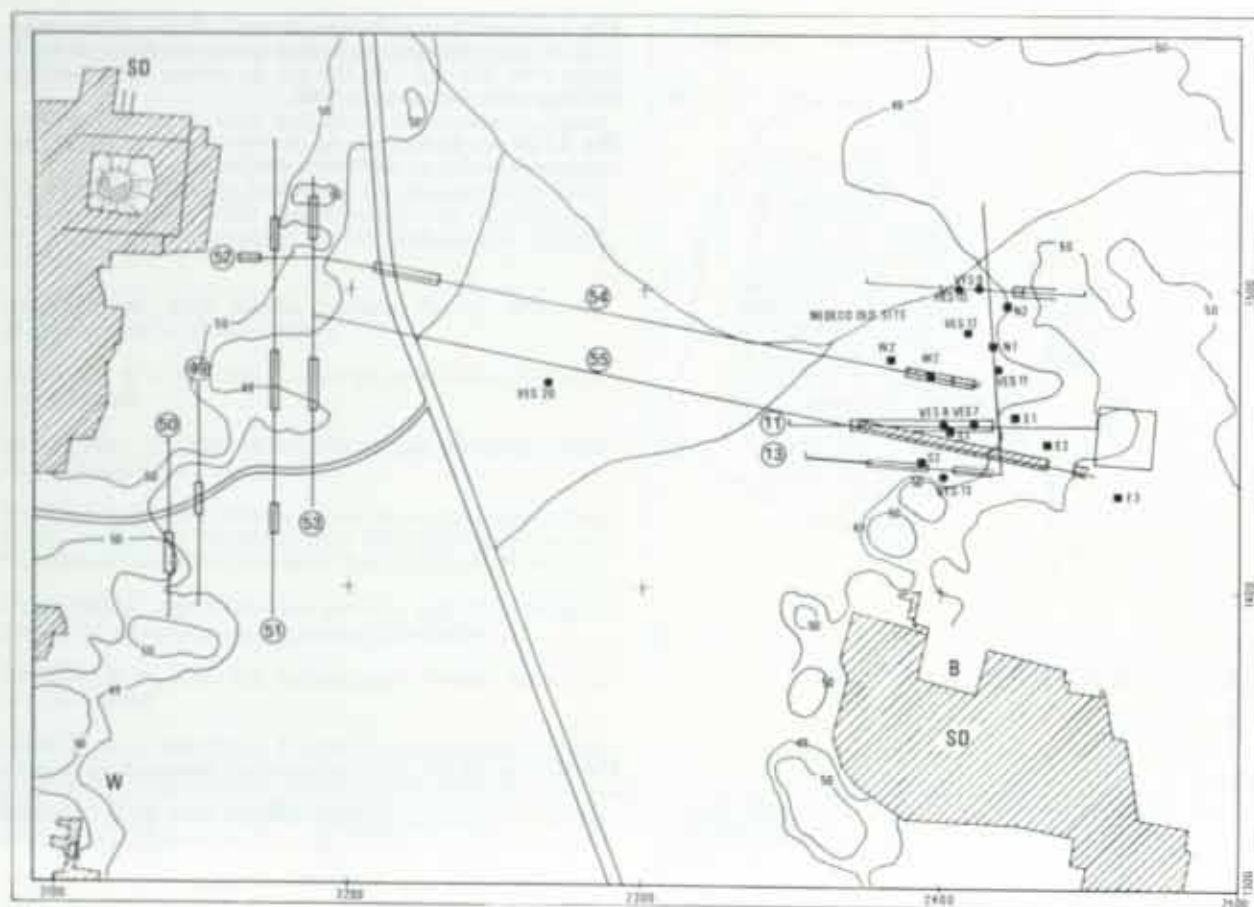


Fig. 3

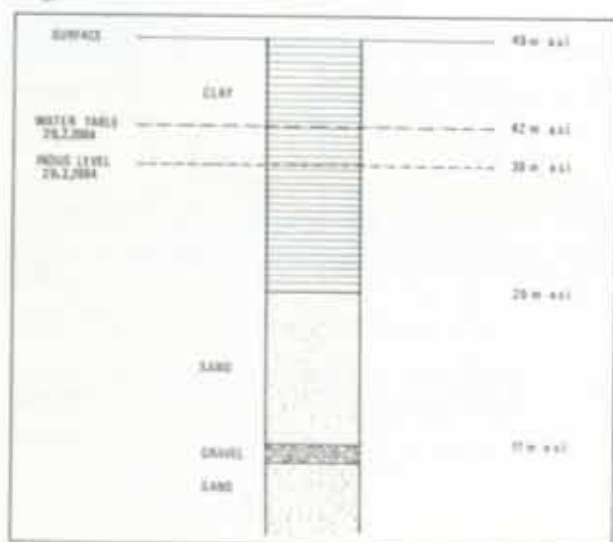


Fig. 4

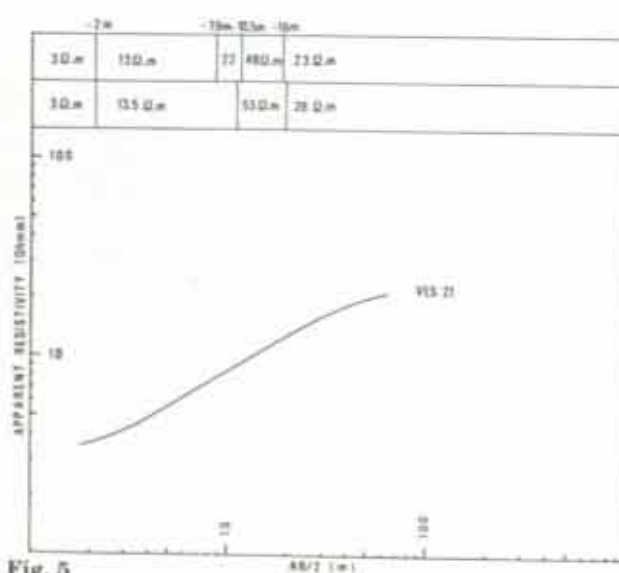


Fig. 5

Fig. 3 Area no. 4: Depression north and south of HR/E with the magnetic profiles (numbered lines) and the relative magnetic anomalies (hatched). VES are the points where vertical electrical soundings (VES) were made and BC (Boring Cores) indicates where borings were carried out.

Fig. 4 Stratigraphic log of boring core BC1 drilled in HR south.

Fig. 5 Vertical electrical sounding VES 21 with the pair of possible interpretations (on top).

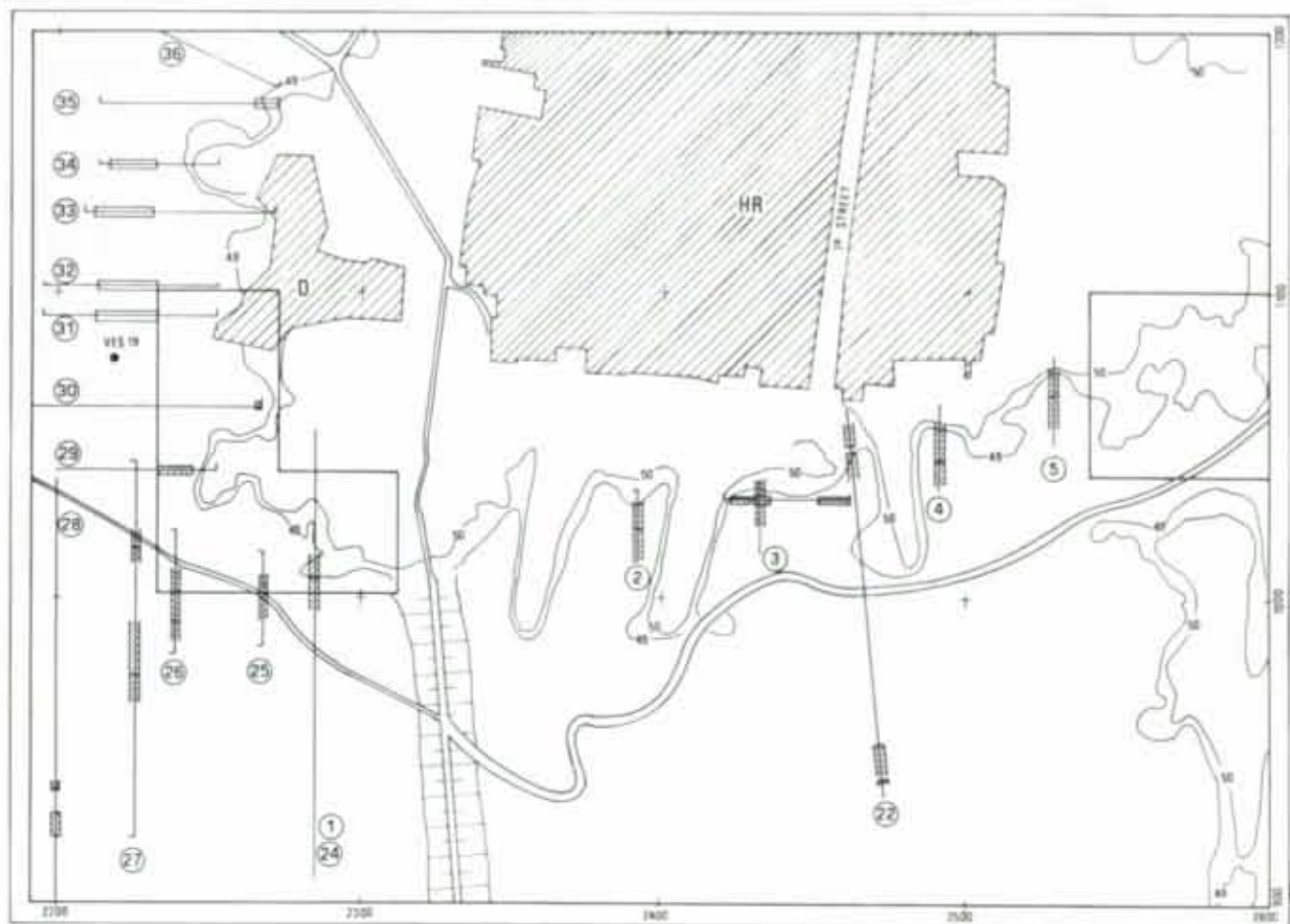


Fig. 6

Fig. 6 Area no. 3: Depression south of HR and D areas with the magnetic profiles (numbered lines) and relative magnetic anomalies (hatched). VES indicate the points where vertical electrical soundings were carried out.

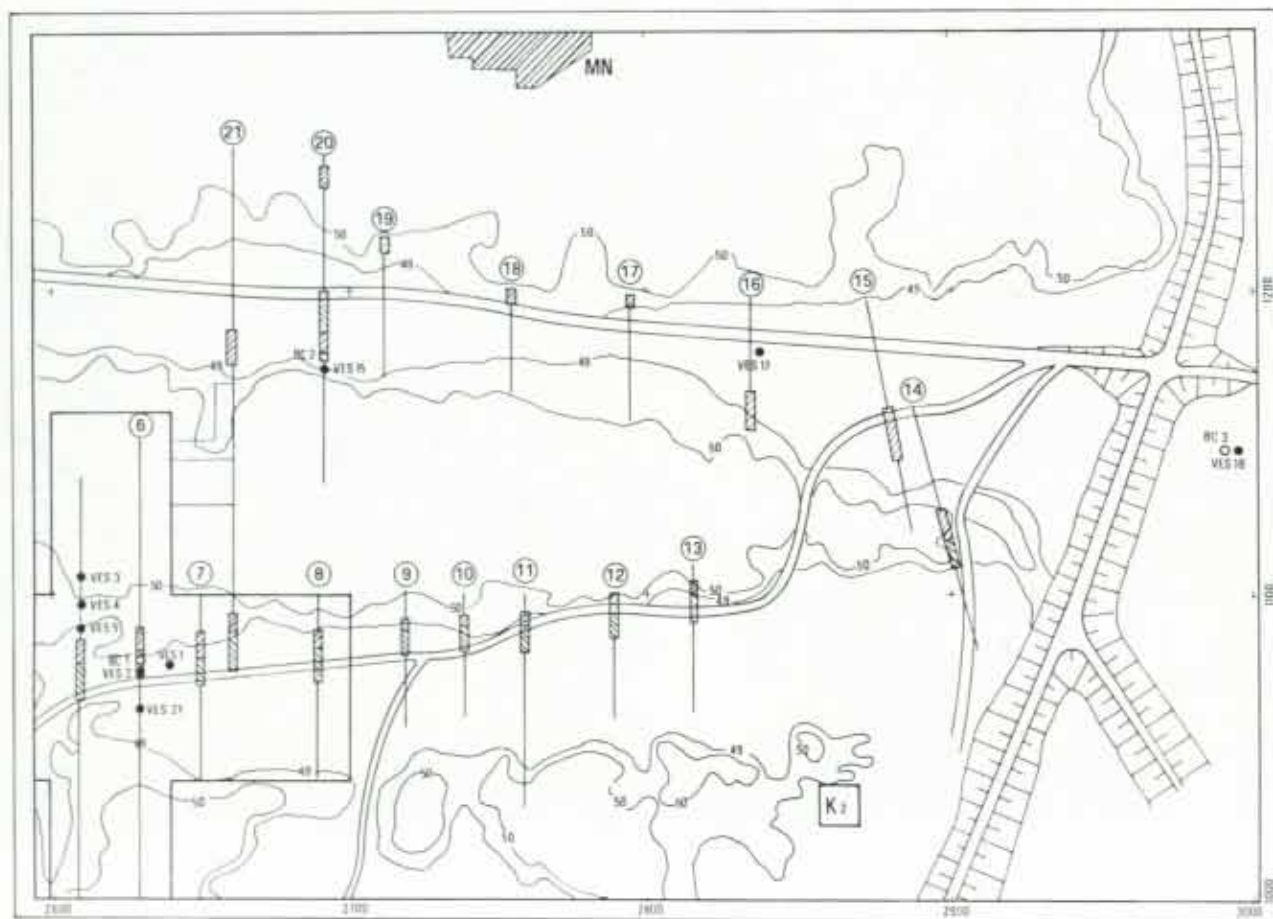


Fig. 7

Fig. 7 Area no. 2: Depression between the Citadel and VS area with magnetic profiles and the relative magnetic anomalies. VES are the points where vertical electrical soundings were made and E1, E2, E3, E4, E5, N1, N2, S1, S2, W1, W2 are the points where the Nedeco company carried out drills in the so-called Old Site.

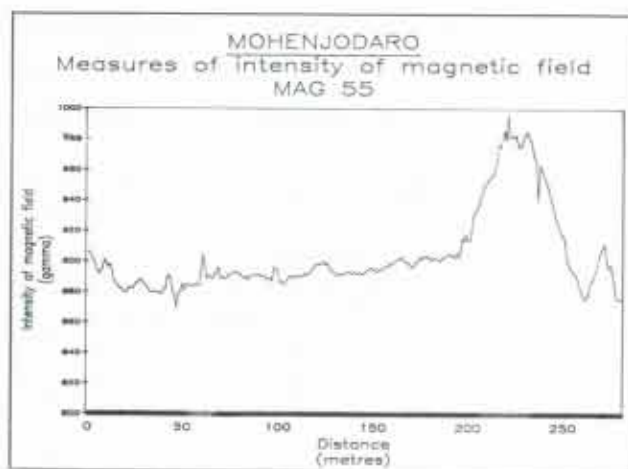


Fig. 8

Fig. 8 Diagram of magnetic profiles *MAG 55* made in area no. 3.

Fig. 9 Vertical electrical sounding *VES 20* carried out in area no. 3 with the stratigraphic interpretation (on top).

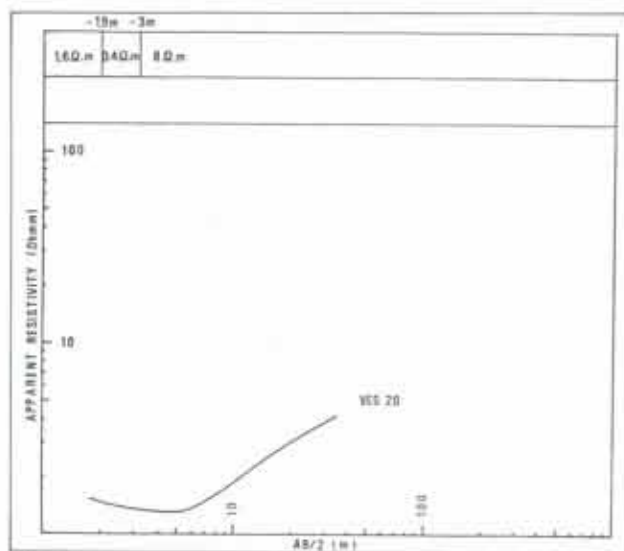
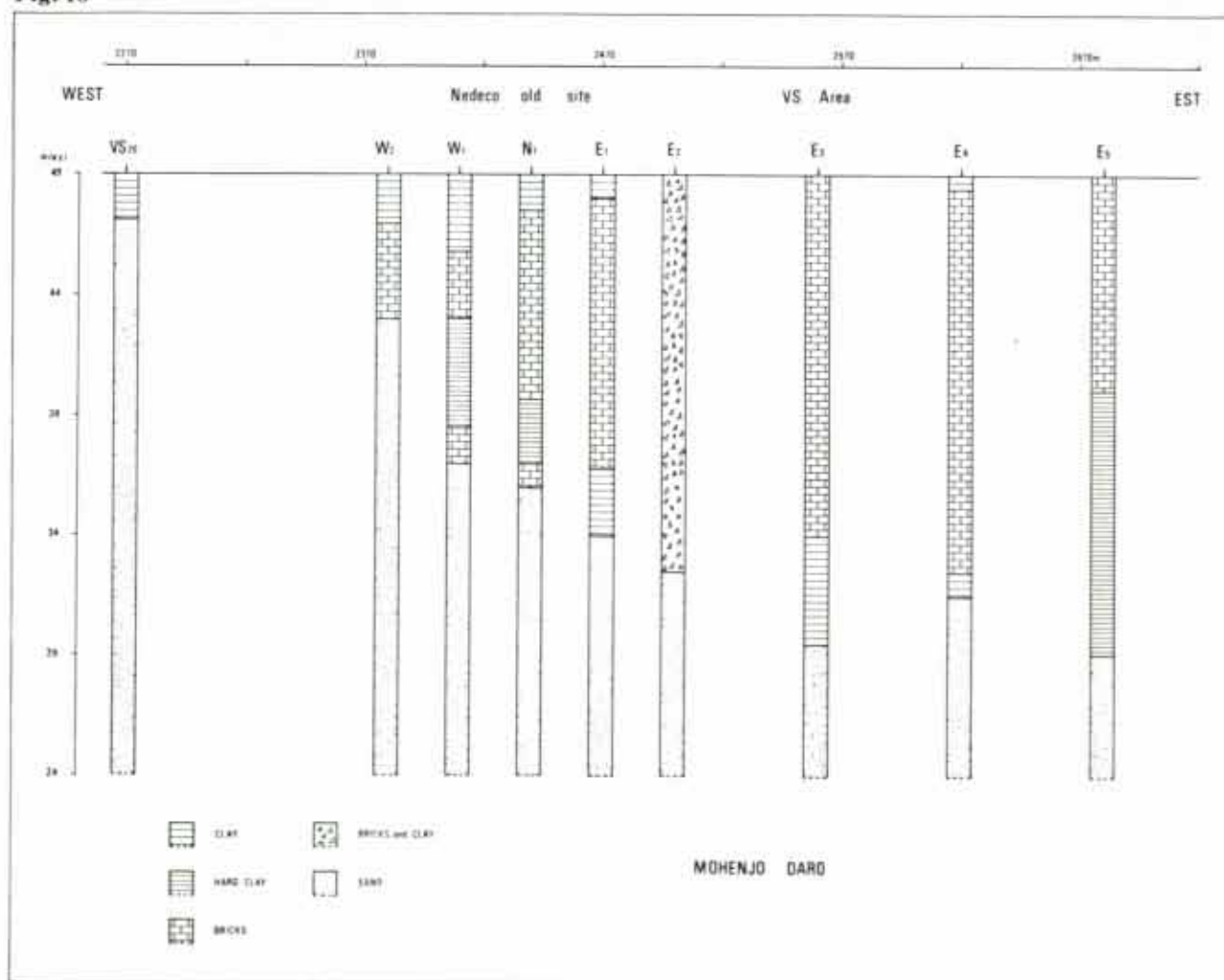


Fig. 9

Fig. 10 Section W-E made with the results of the Nedeco data in the Old Site and with *VES 20*.



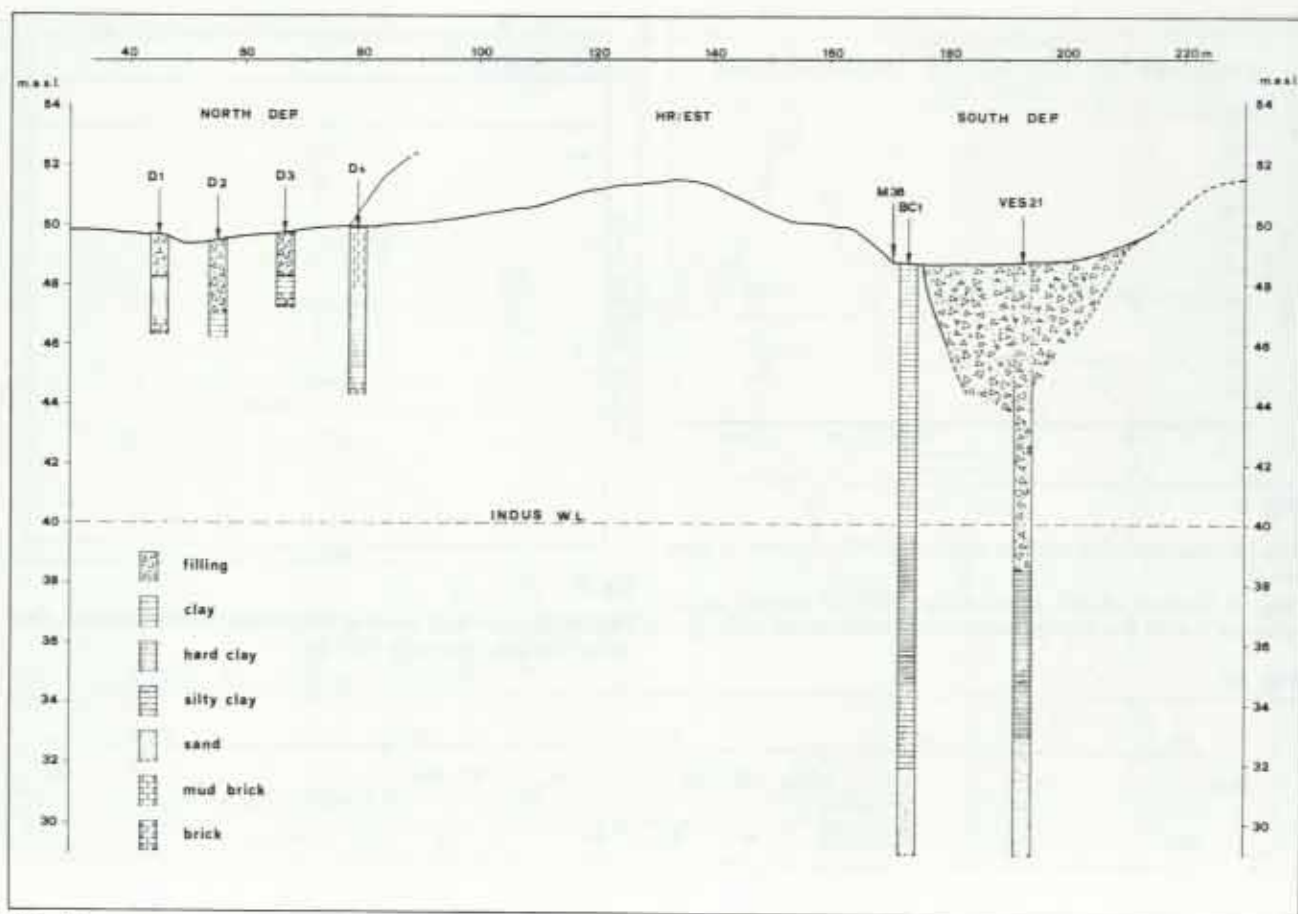


Fig. 11

Fig. 11 Cross-section N/S through HR/E along the magnetic profile MAG 21. Indus water level is that measured on March 1984.

# Preliminary Research on the Degradative Evolution of the Deposits and the Dislocation of Archaeological Indicators of Craft Activities on the Surface of Moenjodaro

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The geo-archaeological research carried out in February 1984 in the site labelled Moneer South-East Area (hereafter MNSE Area) of Moenjodaro is part of the broader Surface Evaluation Programme developed since 1982 by the Joint German-Italian Project.<sup>1</sup> In particular, our contribution may be conceived as an integrative research approach within the parameters of the surface survey of the craft activity areas detected across the compound (Bondioli et al. 1984; Pracchia et al. s.d.), with the specific purpose of understanding *"the effects of erosion on the archaeological deposit, resulting in the spreading of artifacts and the related geomorphic process"* (Bondioli et al. 1984: 11). In this perspective, since 1982, the MNSE Area has already been the subject of an extremely detailed surface survey by M. Vidale, aimed at singling out the distribution of the Archaeological Indicators of Craft Activities (hereafter AICA) (Tosi 1984: 24-25) across the sampled area. Consequently, after a general field analysis of the urban compound of Moenjodaro, we concentrated our efforts on the already selected MNSE Area, allowing an experimental testing stage on the relationship existing between the massive and uneven distribution of AICA and the surface geomorphological setting.

At this preliminary stage we drafted a geo-archaeological map of the area, a first interpretative analysis of the main processes active in the area (salinization and meteoric erosion) before finally proposing an interpretative model on the question of the geo-archaeological system with destructive valence characteristic of Moenjodaro.

C.B. G.L.

## Acknowledgements

We would like to thank M. Jansen and M. Tosi for enabling us to develop the present research. Particular thanks are due to M. Jansen for the aerial photographs of Moneer South-East Area he kindly provided. We gratefully remember the friendly hospitality of all the members of the joint German-Italian team at Moenjodaro. Many thanks are due to M. Vidale for his technical assistance.

## Main geo-morphological features of MNSE Area

The examined area of the mound (40x65 m.) (Fig. 1) in MNSE Area corresponds to a part of the right-hand hydrographic side of the small lateral valleys running down from the Moneer mounds and opening, following an almost normal course, into the wide depression separating the HR insula from the main compound of the lower town. Such a small lateral valley is produced by the partial filling by alluviation of an ancient

structural depression belonging to the town's urban network. Conforming to the altimetric setting normally associated with the residual mounds of the compound, the western side of the small valley departs from a higher elevation and exposes a broader surface than the eastern side. The rare but intense local precipitations thus have the chance to operate onto a wider hydrographic basin; their effect is further enhanced by a substantial component of sub-surface run-off via piping along the slope, due to the water funneling active on the peri-summital plateaus surrounding the central elevations of the Moneer mound, whose structures were extensively undermined in early excavations. These factors cause the substantial degree of dissection characterizing MNSE Area, which is furrowed by a network of erosion gullies ranging in morphology from linear to branched, connecting the plateaus with the floors of the small valleys (septentrional zone, with an average gradient of 10%) or departing from the two secondary plateaus, interrupting the slope with a relative difference in height of some meters (middle-southern zone of the slopes with an average gradient of 15-20%).

The basal basin of the valley thus collects the confluences of the smaller but active tributary basins, and is connected, in turn, with the above-mentioned wide depression through a main channel with ephemeral drainage, characterized by an almost non-existent longitudinal slope (0.5-1.0%). The prevailing geomorphological ranges coincide with a "non-erosion" zone on the plateaus, with an "active erosion" zone along the slopes and a "fast alluviation" zone in the basal basins (Figs. 2 + 4).

#### Criteria of geo-archaeological surface mapping in MNSE Area

The surface survey of the main geo-archaeological residual units in this zone of Moenjodaro (Fig. 3) started from a descriptive decodification according to morphological, textural and compositional criteria, in turn resulting from the recognition of the various degrees of exposition, dissection or weathering of the different local archaeological deposits.

Given such a confusion of outcropping features, in our cartographic schematization we have been compelled to juxtapose residual structural units (i.e. walls and platforms in fired and/or mud bricks), usually occurring on the headwaters of the gullies, and whatever

units resulting from the former ones but which are now partially obliterated by the intense saline weathering (e.g. zone of the plateaus). In the mid-slope sections the deep lateral cuttings of the gullies allowed us to observe, in spite of the partial covering of saline encrustations, the textural and compositional morphology of the deposits formed by intentional fillings or dumped debris. Finally, on the basis of the compositional elements, the matrix inclusions, basic hue of the sediment and the distribution of the main textural classes (evaluated by means of the limited drawings of the sedimentological sampling) we were able to define the relative surface limits among the units more intensely degraded and/or with multiple composition, mainly occurring across the summital plateaus and mid-slopes of the site (Fig. 4).

#### Geo-archaeological units identified in MNSE Area

##### PRIMARY ANTHROPIC UNITS<sup>2</sup>

##### — STRUCTURAL ELEMENTS:

a. Walls or platforms of fired brick (A) including mortar formed by silt with clay and sand; b. walls or platforms of mud brick (D).

##### — DEPOSITS FUNCTIONALLY CONNECTED WITH STRUCTURES (FILLINGS) (G, H, I):

We have been able to define different types of fillings, resulting from re-elaboration with eventual re-mixing of different materials: potsherd-fillings (G), mixed fillings (H), mixed fillings with charcoal (I). These types may anyhow be considered as a single class, given their common function. Their mixed compositional features, moreover, induces an analogous behaviour in relationship to both saline alteration and erosion.

##### — KILN (F):

Presumably installed over an area already in a state of advanced degradation of the structural anthropic sub-strata.

##### — DUMPS (J):

Resulting from domestic and/or industrial activities, performed in presumably abandoned and/or peripheral areas.

##### — OVERFIRED TERRACOTTA NODULES (O):

The scarcity of such indicators on the site prevented us from ascertaining whether they resulted from the decay of a preparatory filling for a structural floor (a widespread technique in the later phases of Moenjodaro) or from the refuse heap of a kiln.

We presume that such a system includes a further type of formation, namely, materials deposited or abandoned on top of floorings, a situation not uncommonly reported by the early excavators. Given the particular constraints of our survey of the degraded surface formations, we have not been able to single out those types of deposits whose presence is expected, given their certain association with AICA distributions.

Collapse formations do not range among the geo-archaeological units considered, because, although rather frequently observed in other contexts at Moenjodaro, they have not been identified in MNSE Area (they would presumably be encountered in sub-surface contexts). On the other hand, in accordance with their genetic definition and their composition, they would represent either a sub-aggregate of fired brick or mud brick walls, or an aggregate of these latter elements intermixed with materials sustained by floorings and/or contained by walls, therefore corresponding to deposits of different composition depending on the situation.

#### DEGRADATED ANTHROPIC UNITS

##### — RESIDUAL DEPOSITS:

a. Deposits containing various elements produced from decayed fired-brick structures (*B*): these are formed of fragmentary bricks, fragments of bricks of various sizes and, eventually, of flakes and granules of the most effectively disintegrated fired materials. Usually they may be found downstream and/or at the sides of exposed wall structures, or they mark sub-surface structural alignments.

b. Deposits affected by the maximum degree of saline weathering (*C*): they are formed by the minute granular-products resulting from the disintegrative evolution of fired-brick structures. They represent the type of residual unit prevailing on the surface, particularly common on the summital and mid-slope plateaus of the site.

c. Deposits representing the final output of saline weathering operating on mud-brick structures (walls and platforms) (*E*): they display extensive formations with a mainly silty-claylike texture, and occur across the peri-summital plateau and on the septentrional strip of the slopes. The weathered intermediate products, small flakes and flattened mud crumbs, are exposed only along the sides of the gullies; they have also been encountered in the profiles revealed during the sedimentological sampling (horizon "B" of the standard saline profile).

d. Granular products with mainly sandy-silty texture, enclosing intermixed cores of minute particles of fired brick and/or crumbling sherds; the matrix contains various scatterings of minute charcoal debris. Their origin may be traced in limited processes of re-sedimentation of units of type *C*, *E*, *I* (resulting from eolic actions, trampling and localized re-deposition by

surface washout). Such units have been determined only in the mid-slope zones, in association with a small intermediate plateau.

#### SEDIMENTARY UNITS FROM HYDRAULIC-GRAVITATIONAL RE-DEPOSITION

##### — FILLINGS OF GULLIES AND CHANNELS (*N*):

They are discontinuous, lenticular shaped elements, generally stratified (strata of type "cut and fill" and "planar-through cross stratification"), with prevailing granular and coarse-sandy textures, having greater values of hydraulic sorting downcurrent.

##### BRANCHES OF GRANULAR, WASHED-OUT MATERIALS, DEPOSITED INTO THE TERMINAL BASAL BASINS OF THE SLOPE (*L*):

Repetitious sub-tabular sequences of sands, granules and silts, with low grade of assortment, output of the sheetflows active in the downstream sectors of the slopes.

##### — MUD AND DEBRIS FLOWS (*M*):

Spatially limited fans with lobe-shaped borders, with heterogeneous matrix. They are dislocated by water saturation, chaotically re-mixing materials from anthropic formations, both primary and degraded, together with various concentrations of overfired clay residues and overfired terracotta nodules.

#### KEY TO THE GEO-ARCHAEOLOGICAL MAP UNITS

A-Fired brick walls: wall structures of floorings in fired brick, exposed and/or partially protruding.

B-Collapsed and fragmented fired bricks with their disintegration products.

C-Prevalent sandy-silt deposits produced by the intense alteration and disintegration of fired bricks.

D-Mud-brick walls and platforms.

E-Prevalent silty-clay deposits, produced by intense alteration of mud bricks.

F-Kiln area with charred residues.

G-Potsherd-fillings: fillings with prevalent potsherd inclusions in sandy-silty matrix.

H-Mixed fillings: fillings with non-selected artefactual inclusions with prevalent matrix.

I-Mixed fillings with charcoal: fillings with non-selected artefactual inclusions in matrix containing charcoal particles.

J-Layered waste dumpings: repetitious, lenticular-shaped sequences of charred deposits and layers with artefactual inclusions, partially burnt bone fragments, and spread charcoal bits.

K-Sandy-silt deposits produced by re-mixing materials of the types C, E, I.

L-Stratified deposits with medium-sized sand particles forming the pediments.

M-Mud and debris flow.

N-Hydraulic network with inner deposits.

O-Overfired terracotta nodules.

## Salinization

Salinization represents the main process of surface weathering of the materials outcropping on the site, in respect of both the structures and the inclusions contained in the residual deposits. Such a process apparently depends upon the relative level of the phreatic groundwater limits (whose depth ranges 1.5-3.5 m. from the average p.c.: 40 m. a.s.l.), fed from the subalveal waters of the Indus River east and the Dadu Canal to the west. The arid climate characterizing the area (with variations of temperature ranging from 45° C in June to 7° C in January, besides the frequent, strong local winds) encourages, through the potentially high rates of evaporation, the capillary rise of saline solutions (salt contained in the groundwater) up to 9 m. above the base of the capillary fringe. Surface evaporation causes the fast crystallization of the salts present in solution ( $\text{Na}_2\text{SO}_4$  and  $\text{K}_2\text{SO}_4$ ,  $\text{NaCl}$  and  $\text{KCl}$ ,  $\text{CaCO}_3$ ,  $\text{MgCO}_3$ ,  $\text{Ca}(\text{HCO}_3)_2$  and  $\text{Mg}(\text{HCO}_3)_2$ ), in turn producing substantial stresses within the pores and micro-fissures of the vulnerable materials which can lead to progressive granular disintegration. The micro-morphology of the salinized deposits of Moenjodaro conforms to the local topographical variability, showing whitish, powder-like encrustations in the lowland areas (damp salt crust) and along the slopes a dry, crust-like efflorescence (as observed in MNSE Area), to finally disappear in the highest parts beyond the range of the ascending capillarity (capillarity fringe limit).

Our limited sample drawings, together with observations of the sediments exposed along the sides of the gullies, allowed us to de-codify a type-profile of saline weathering developing on the sub-strata of the site (Fig. 5). On the surface there is a strong saline encrustation (0) ranging in thickness from a few mm. to some cm., usually cementing an aggregate of granules of fired materials, chips of overfired clay, some rarer lithoid elements, etc.. We then encounter a powdery layer (A) with an average thickness of 5-7 cm., whose very homogeneous granulometric composition ranges from a sandy silt to a silty sand with a limited presence of thinly brecciated fired particles. The soft consistency of this horizon is due to the sudden and complete evaporation of hygroscopic solutions, leaving series of voids in the structure of the sediment, combined with a organization of the granules into a characteristic soft fabric. The following horizon (B) ranging, as a rule, between 7 and 25 cm. depth, appears as a moderately silty sand, joined to a more discrete fraction of small fired-brick breccia in a phase of disaggregation. Along fresh cuttings we would observe that such residual small particles become capturing media for saline solutions, and appear, after a few hours, entirely covered by clustering of gypsum needles, in turn

producing smaller crystallization in the sediment mass, following diverse vertical courses. We observe furthermore a transitional horizon (B/C) marked with a spread of ghost brick-clasts intermingled with an abundant microbreccias and granules fraction coming from the fracturing, scaling and disaggregating of loose structural pieces (baked bricks and lumps of mud bricks: 25-40 cm). Lastly, at a depth of about 40 cm., we find the sub-stratum (C), unaltered or just slightly altered, moderately moist, and characterized, once exposed and rapidly dried, by a coating of minute crystallization flakes, which in a few hours totally cover the surface of the layer. Here is preserved either the sedimentary structure of the primary deposit (in the case of incoherent formations) or the structural network of the wall or platform (both in fired and mud brick), without any evidence of saline alteration of the included elements, whatever their composition or micro-porosity features.

## Erosion

The surface encrustation produced by the salinization dynamics turns out to protect the site considerably from eolic erosion, although we were able to identify some limited zones in which this latter agent may operate (human and animal pathways and slope sections where differential thermal dilation destroys the surface crust, with the consequent exposure of the underlying incoherent horizons). In the general model of disintegration reconstructed at Moenjodaro we therefore did not take into account such a class of erosive-depositional processes; we also ignored fluvial erosion, as non-effective in the present state of the hilly compounds and definitely absent in MNSE Area.

The main erosive process operating throughout the site is hydraulic corrosion from meteoric precipitations, as evidenced by the system of rills and gullies which are almost ubiquitous across the slopes of the compound, developing, at the base of the mounds, a network of secondary furrows feeding the primary channels, in turn emptying their bed load into the wider depressions (lanes) cutting the mounded region. Given the very ineffective vegetation existing on the site, and equivalent average yearly rainfall conditions less than 100 mm. and mainly concentrated in the late summer quarter erosion, at first general and later channeled, depends on the original gradient

of the slopes (10-15%) and, as a consequence, upon the relative susceptibility to transport of the materials powdered in the saline profile once the surface crust has been re-solubilized by the first, intense precipitations. On the other hand, the original geo-morphological setting of the slopes is affected by the diversification of the emerging structures, whose variability in terms of orientation and inner composition leads to the creation of pre-ordered catching networks. The differentiation of the emersion altitude of the residual structural aggregates causes, furthermore, the alternation of more limited plateau-like morphologies in correspondence with the mid-slope sectors. The gullies' courses, although confined within the constraints of the geometric network of the site, incline to recover their natural equilibrium profile, therefore resulting zones of accelerated erosion, more and more intense according to the extent of the anomaly produced by artefactual features. Finally, it is remarkable that the removal of the incoherent salinized formations (mainly occurring along the flanks and the headwaters of the gullies) during the most intense rains creates localized expositions of the underlying more thickened deposits, which, barely coherent and saturated on the surface due to a limited seepage capacity, slip in mass along the gradient and into the furrows, generating lobes of mud and debris flows. Such deposits will be subsequently in part dismantled by the surrounding channeled hydraulic activity, or, if activated along the distal flanks of the terminal slopes, they will reach the axis of the valley, where they will be gradually re-assorted by the hydraulic transport active in the channels.

Erosive processes differentially denude the saline horizons we previously defined (*A, B, C*) according to the site's micro-morphology, down to expose in some zones (e.g. the gullies) the very unaltered substratum; these dynamics, in relationship with the degree of erosion, allow the re-starting of a differentiated salinization process, a process, therefore, that may be deemed at least partially cyclic (*Fig. 7*).

### Interpretative Models

The schematic model in *Fig. 8* presents the progressive stages of erosive degradation developing from a standard saline profile (i.e. defined by the extreme grade of evolution *A, B, C*), the relative residual

deposits (*B, C*) and the relative removal deposits, re-distributed with a selective assortment (hy.A), selective-channeled assortment (hy.B) or non-assorted (hy.g.A+B). The model moreover expresses the possible re-starting of the saline weathering both from the different residual deposits (*B* evolving to *A1*, *C* evolving to *B1* and therefore to *A2*) and from the neo-formed sedimentary deposits (hy.A, hy.B, hy.g.A+B), directly forming a new sub-stratum (*C1*) potentially object of the same saline evolution.

In the building of the described model we necessarily adopted some interpretative-processual simplifications. The three horizons produced by the saline process have been considered as discrete elements while such a saline profile has a continuous nature. As a matter of fact, horizon *A* contains, although in minimal percentage, some granulometric classes not completely removable by sheet erosion, as horizon *B* may present some classes with critical diameter not removable by gully erosion competence. Similarly, the complex of erosive behaviour has been sub-divided into the inner segments we considered more relevant from the processual viewpoint: in a sequential relationship of linked increment (sheet-gully) or, for what regards mud and debris flow (in our model operative only from the extrapolated horizons *A* and *B*) without considering that such terms may also maintain an interactive link with the above mentioned hydraulic processes.

The scheme in *Fig. 9* shows how the two models in *Figs. 8* and *10* are not limited to a graphic device to express the interactive processes among salinization, erosion and deposition. As a matter of fact, reading the various columns ideally superimposed one may observe the processual-diachronical evolution of the system, while, reading the columns' sequence from left to right it is possible to follow in a spatial perspective the main geo-morphological sectors of the site: 1st column = plateaus; 2nd column in point *B* = slopes; 3rd column in point *C* = gullies; while the inferior sequence (hy.A, etc.) indicates the context of the basal basins.

In the model presented in *Fig. 10* we examine the behaviour of the artefacts not attackable from saline weathering (mainly lithic and vitrified clay AICA — cf. *Bondioli et al. 1984: Tab. 3* — and other classes of overfired ceramic residues); contemporaneously, the disaggregation of the included elements by salinization and the subsequent spoiling of the soil matrix conform to the processual dynamics presented in the preceding model (*Fig. 8*). The model of *Fig. 10*, therefore, indicates only the outputs of hydraulic-gravitational re-assortment, of their subsequent concentration in situ, as well as of the eventual hydraulic dislocation of the above mentioned artefacts. The alphabetic symbology adopted for the artefactual component of the three horizons of the standard saline profile (*A* = AICA; OF = other overfired clay residues) was intentionally expressed in equivalent quantities, so that the evaluation of their

spatial behaviour (vertical or dislocative) may be quantitatively checked both in terms of increment and decrement, in linked relationship with origin from the originary aggregates (A, B) to the supporting ones (B, C) and with the relative depositional outputs (hy.g. A+B, hy. A+B). For instance, horizon C, final output of erosive processes, maintains the same quantities it formerly had with the superimposition of the total amount of inclusions of the starting terms A+B (transported by mud and debris flow) and of the assemblage of the inclusions of A and B, deprived of a given fraction (hy. A+B) dislocated by channeled hydraulic transport (gullies).

## Concluding Remarks

The geo-archaeological mapping of MNSE Area displayed the articulation of the surface formation in *primary anthropic units, degraded anthropic units and sedimentary units from hydraulic and hydraulic-gravitational re-deposition*. By interfacing the geo-archaeological map with a preliminary distributional map of a complex of lithic AICA (Fig. 11; see Vidale's report on the MNSE semiprecious stone industry in this volume) we may individuate some figures of greater or minor presence or virtual absence of such indicators. The major concentrations apparently occur on sectors of slopes proximal to plateau areas; extended scatterings of lithic AICA follow the pathways of the main furrows; less concentrated clusters appear to be correlated with zones affected by mud and debris flows. Lastly, very rarefied scatterings are distributed, with decreasing order, from the summital plateau to the filling of the basal basins.

It is necessary to premise that at the present stage of the research it does not seem possible to state whether the AICA distribution in primary depositional context was spatially indifferiated or not (merely in terms of primary presence or absence). In the light of the dynamics of interaction among the main disaggregative-erosive-depositional processes we proposed, and in accordance with the outlined models of spatial-temporal range, it is possible to offer two main interpretative evidences, the first one of geo-morphological type, the second one of geo-archaeological/anthropic order, both having analytic-processual character.

1. On the slopes contiguous to the mid-slope plateaus the selective wash-out by sheet erosion of the matrix

clearly tends to concentrate the included AICA without dislocation; parts of the artefacts may selectively be captured by the gullies' channeled erosion, therefore moving downstream in extended scattering within the boundaries of the erosive furrows. Within the basal basins the rarefaction of the AICA occurrence conform to the expected hydraulic laws of gradual decrement of the capacity of transport (decrease in tractive force caused by transmission losses in the channel sediments (Wells 1980)) with the consequent deposition of the greatest majority of the artefacts along the gullies' sides and basal lobes, while the residual elements reaching the channels result to be covered by the prevailing medium-fine sediment in transport. On the summital plateaus, finally, the prevalence of saline weathering processes and the almost total absence of erosion explain the predominant presence of accumulations of disaggregating materials, obliterating the eventual sub-surface presence of AICA. Such a morphogenetic system operating in the MNSE Area — and presumably in wide sections of the Moenjodaro compound — unavoidably stresses the probability to find the greatest AICA concentrations in the sloping zones peripheral to the various mounds (without considering, in this perspective, the eventual chronological differentiations).

2. The analysis we carried on till now necessarily leads to consider — although in the light of our models — the actual behaviour of the interactive actions of saline weathering and hydraulic-gravitational erosion, determining the progressive dismantling of a complex anthropic structural aggregate. Such natural processes, although "constrained" or "channeled" by a well defined urban network, cause an erosion that, removing the matrix, redeposit "in situ", but always at an inferior altitude (cf. Fig. 10) the artefacts that cannot be chemically attacked (AICA and other overfired clay residues). Concerning the relationship between AICA and originary geo-archaeological units, the artefacts, dislocated by channeled water action, may be considered in terms of simple noise.

In short, although at the present stage of the research we cannot evaluate the chrono-stratigraphic thickness of the removed fractions, it may be stressed that the prevailing factor turns out to be the dismantling, across different localizations, of the less structured bodies (3), namely:

A. "Horizontal figures", corresponding to eventual trampling floors, residues of domestic/industrial activities abandoned on pavements, and dumps, with an analogous functional ambivalence, transported in areas presumably contiguous/peripheral and anyhow no more in activity. Such deposits, rich in artefactual remains related to craft activities — in spite of their spatial and stratigraphical variability, must be deemed as the most specular, and so diagnostic, indicators of the performed transformational sequences: the above mentioned deposits because, cleared from the matrix,

maintain in situ the residual evidence of the activities; the dumps, although characterized by a minor grade of definition, represent *cumulative* outputs of the same events and may reliably postulate nearby activity areas. B. "Structural fillings" corresponding to structural raisings of pavements or cubing inner deposits of whole rooms, with the purpose of re-structuring dwelling complexes (houses or quarters) up to produce wider alterations of the urban network. In the framework of such re-structurations — different in time and space — it clearly results that moving from the limited transformation of a domestic space to the alteration of an urban sector, the valence of the operations changes exponentially, determining corresponding alterations in the planning dimension of the materials' removal, as well as in the localization of the drawings (as a rule formed by secondary anthropic deposits, or by formations intentionally changed into secondary ones).

For the purpose of the present study we may thus postulate that the more such operations were localized and small-sized, the more the relative fillings will turn out diagnostic of the relative activities, and, as a consequence, the more reliable will be the AICA evidence uncovered by erosion. We should not anyhow forget that (differently from the figures of type A.) it is not automatically possible to assume a proximity of drawing from the activity areas in relationship with the fillings' allocation. Locally, the different nature of the fillings observed in the MNSE Area (units G, H, I) occurring in closely contiguous sectors (but not necessarily contemporaneous) may be taken as an example of the above discussed genetic variability.

This complex of analytical and hypothetic-deductive observations leads to the inference that the surface output in the MNSE Area and other localizations of the Moenjodaro mounds corresponds to a *palimpsest* — more or less accentuated according to the degree of degradation the sites underwent — conceived as a *cumulative summation* of a portion (whose extent now we cannot evaluate) of deposits possibly different both from the functional and the chronological viewpoint.

In this phase of preliminary research we decided to try to lay down the basic terms of the question, postponing the perspective of a more critical analysis and the relative generalized spatial-chronological-functional models to a future increment in the available evidence.

An essential contribution will result from the operations of interfacing among AICA distribution and geo-archaeological units, already begun on the field with a portable computer together with L. Bondioli and M. Vidale. A further step will be represented by the future field research planned for winter 1985/86; in this phase the research will be addressed, also through experimental texts with short-medium time resolutions, to the control of the *time-erosion* relationship, as well as of the interrelationships between "pure" geo-archaeological units and quantitative/qualitative presence of

AICA, thus defining a graduality between the areas providing reliable indications on craft activity and the "secondary" ones, more contaminated by the summation of the erosive dynamics and the archaeological *palimpsest*.

#### Footnotes

1. The geo-archaeological survey has been carried out by C. Balista, while the interconnection between geological and anthropic aspects has been developed by G. Leonardi, who also effected the construction of the various models, fruit of a continuous scientific interchange.
2. With the term "*primary anthropic units*" we specifically define any non-post-depositional anthropic deposit. We took into account only the anthropic formations encountered in the site under examination.
3. As a matter of fact, from this viewpoint, walls and platforms, either in fired or mud brick, may be considered noise in their quality of non-potential distributing terms of AICA.

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Fig. 1

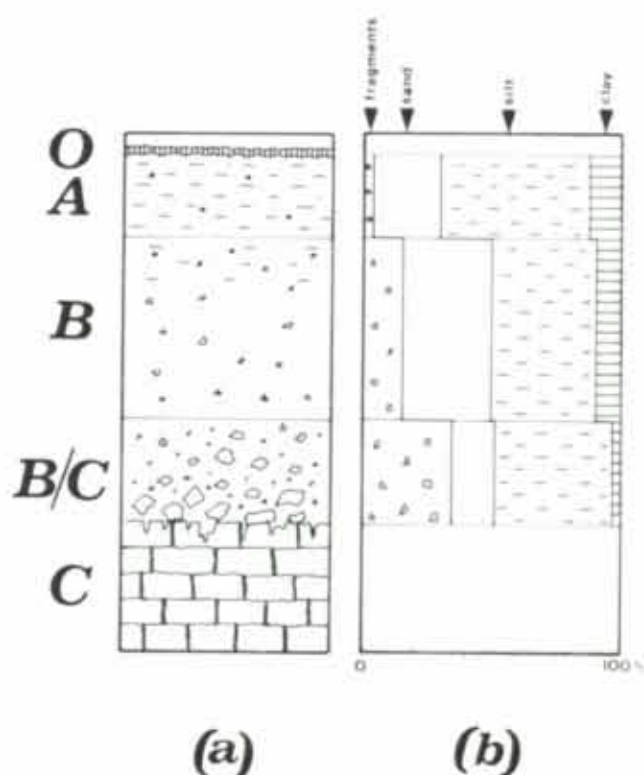


Fig. 3

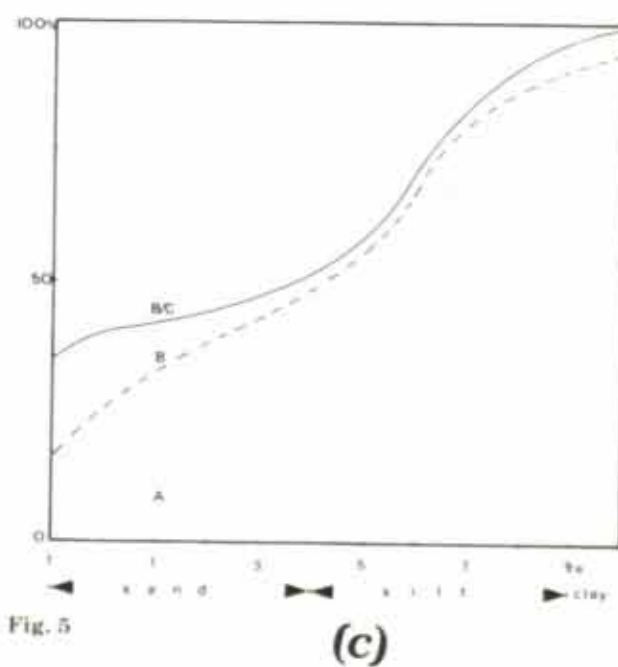


Fig. 5

Fig. 1 Aerial view of the Moneer South-East Area from the hot-air balloon (by courtesy of M. Jansen).

Fig. 3 Partial view of the MNSE Area.

Fig. 5 Simplified scheme of the main geo-archaeological processes active in the examined site (C. Balista).

Fig. 2, 4 ▶

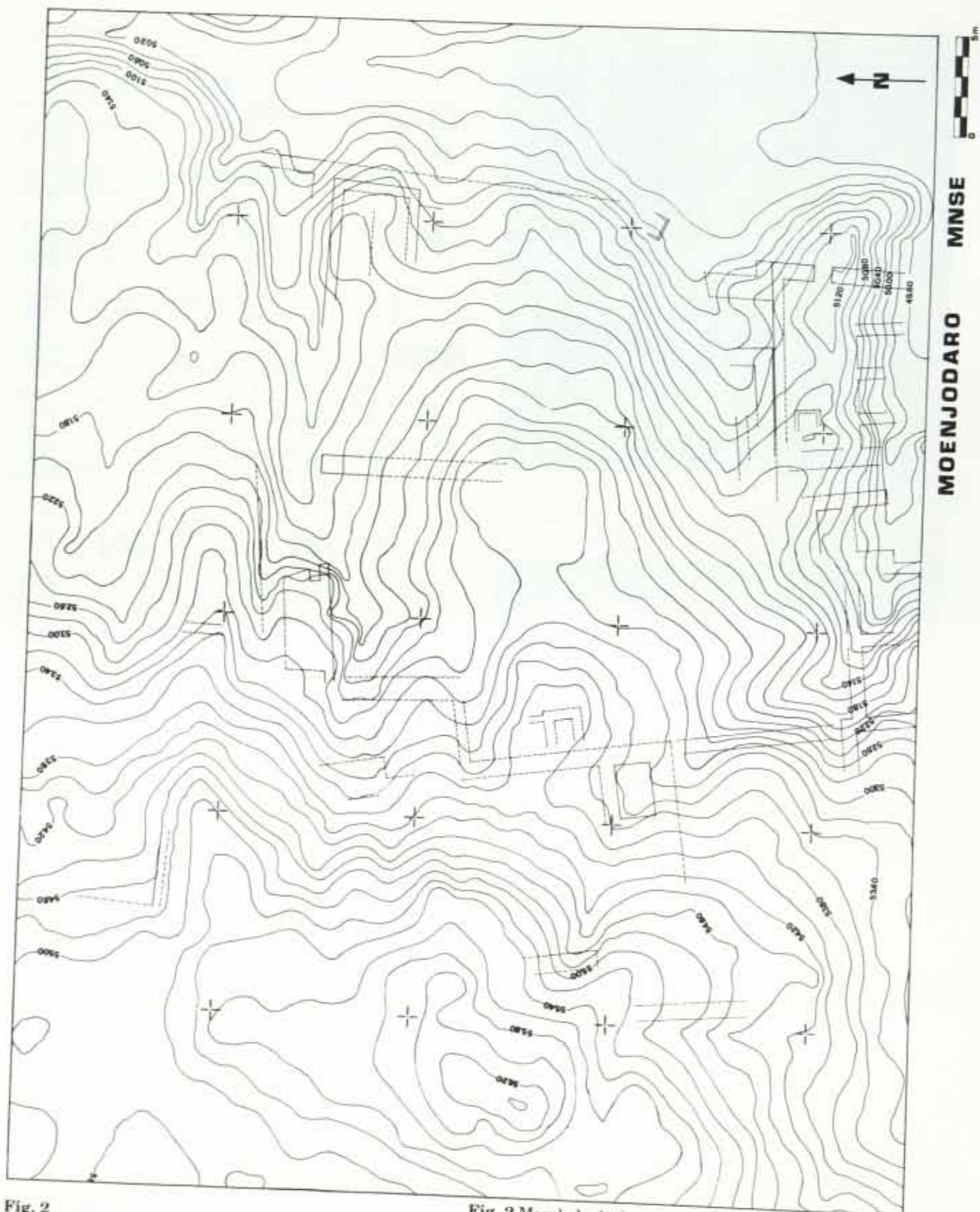


Fig. 2

Fig. 2 Morphological setting of the MNSE Area (drawing by T. Urban, M. Vidale, L. Mariani).

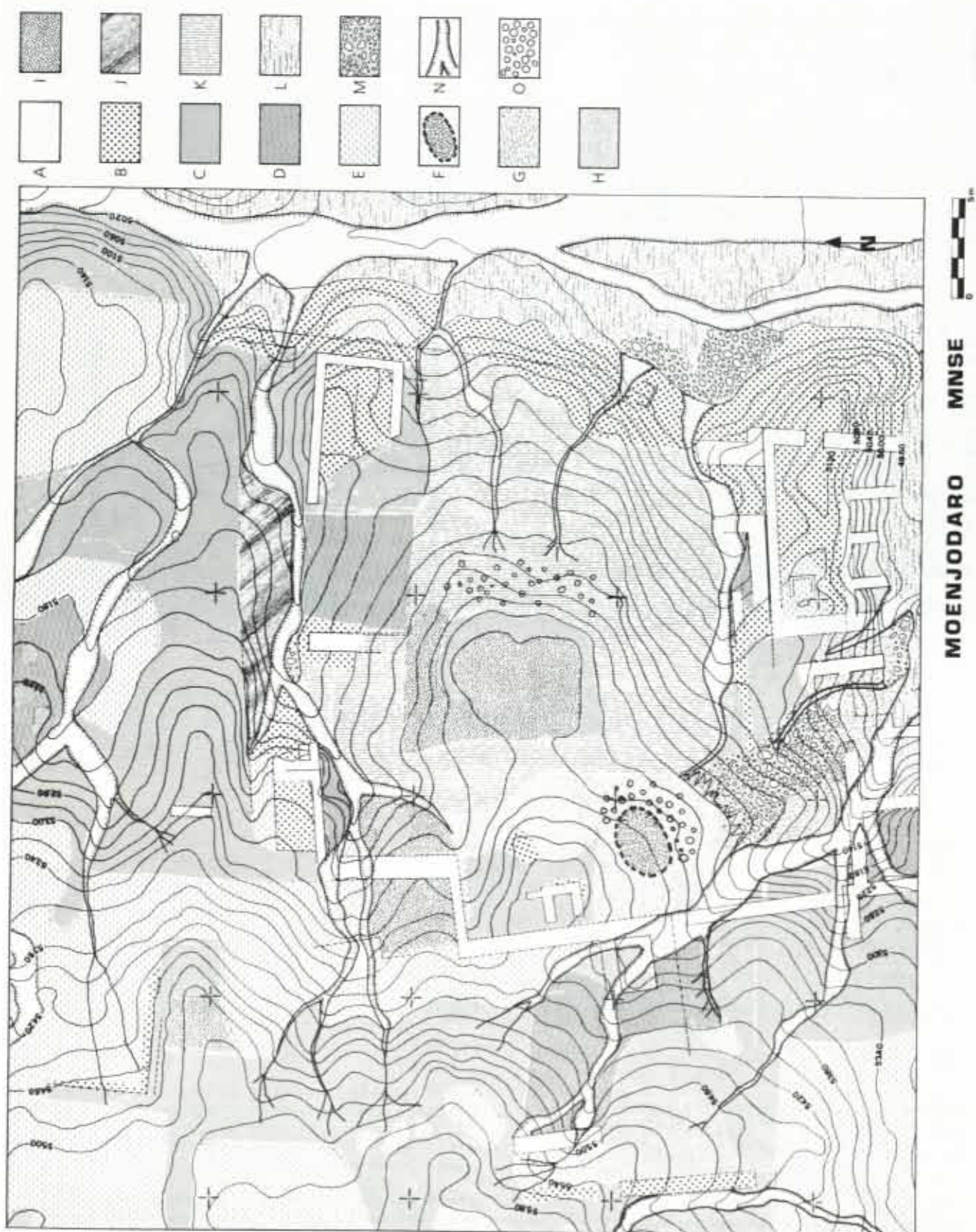


Fig. 4

Fig. 4 Geo-archaeological map of the MNSE Area (survey by C. Balista, drawing by R. Pagan).

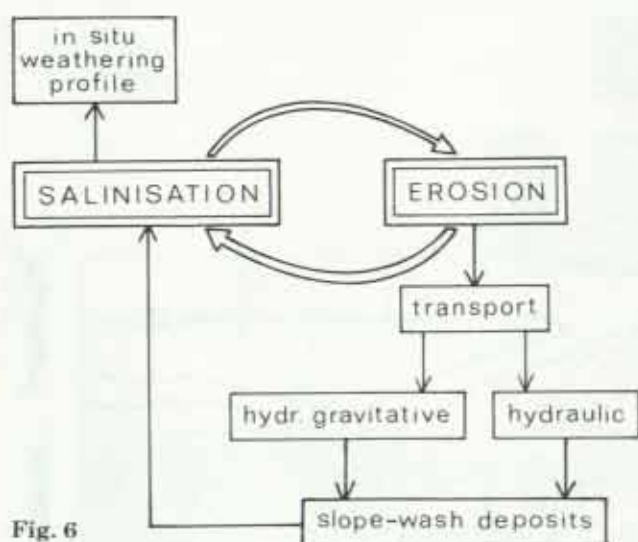


Fig. 6

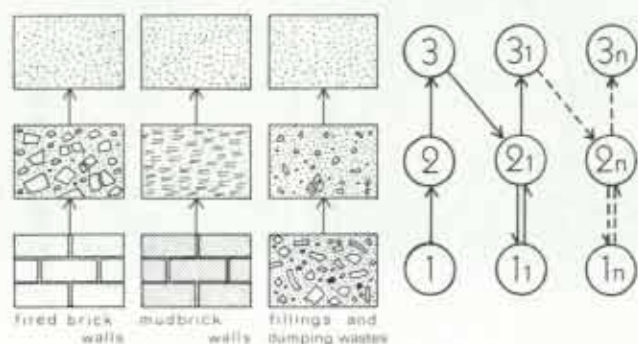


Fig. 7

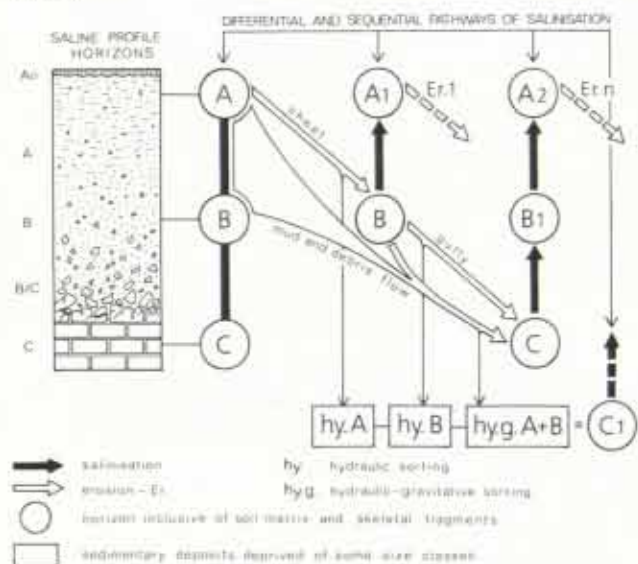


Fig. 8

Fig. 6 Model granulometric diagrams relative to salinization process: a. saline weathering profile; b. percentual distributions of the typical textural classes; c. cumulative granulometric graph (C. Balista).

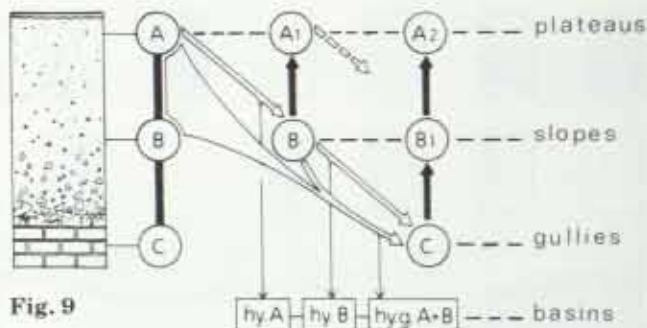


Fig. 9

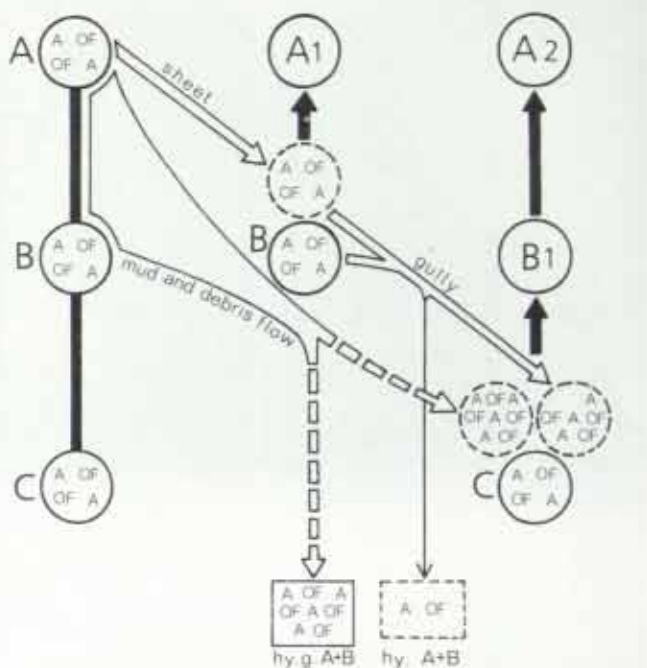


Fig. 10 Model of the re-deposition and dislocation of Archaeological Indicators of Craft Activity (G. Leonardi).

Fig. 7 Simplified scheme of the cyclic evolution of saline profiles, re-started by water-erosion processes (G. Leonardi).

Fig. 8 Model of the interaction between salinization and erosion processes (G. Leonardi).

Fig. 9 Correlation scheme on the graphic and conceptual ambivalence of the models in Figs. 8 and 10 (G. Leonardi).

Fig. 10 Model of the re-deposition and dislocation of Archaeological Indicators of Craft Activity (G. Leonardi).

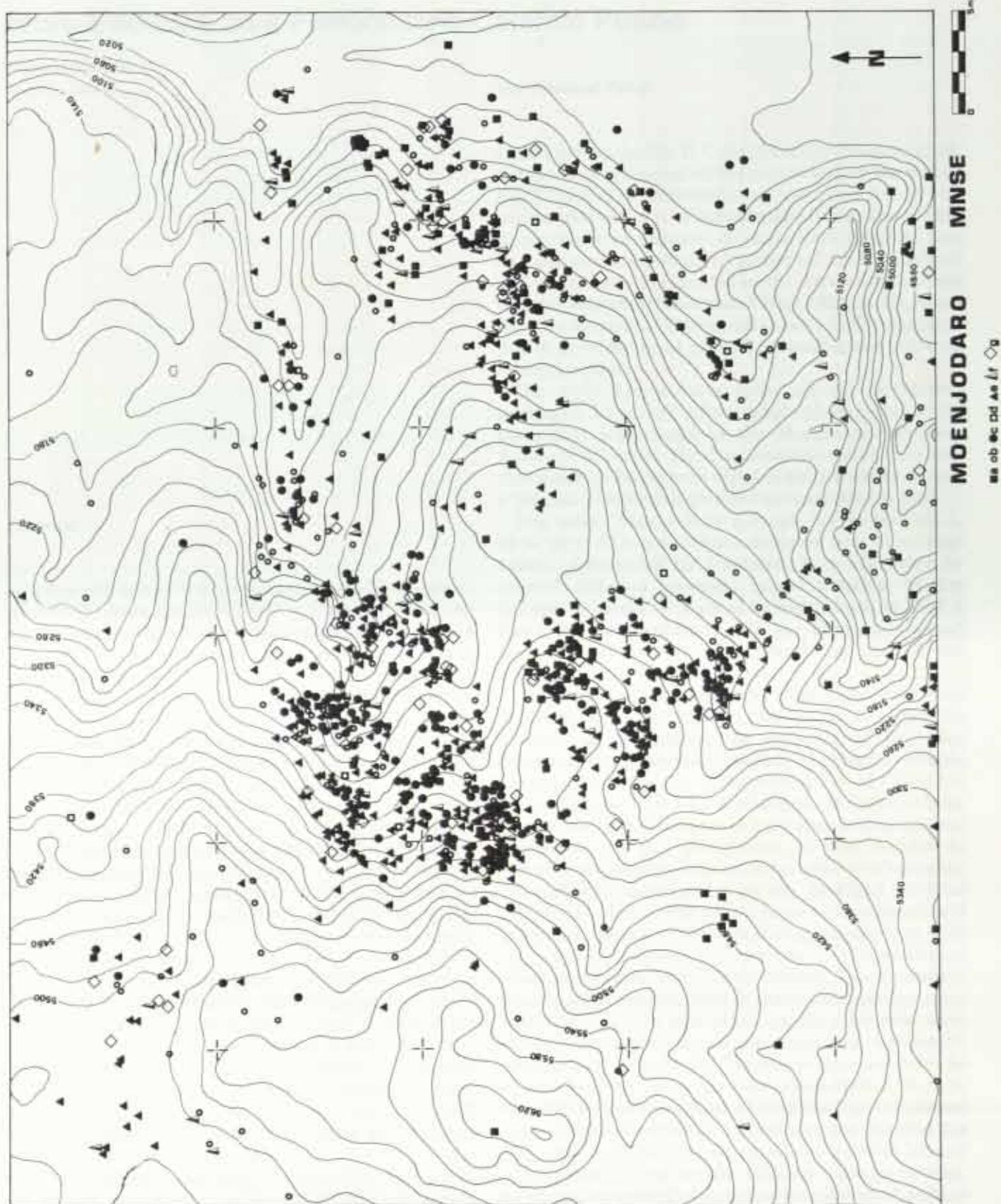


Fig. 11

Fig. 11 Distributional map of selected classes of lithic AICA in MNSE Area (for the explanation of the symbols see Vidale's report on the industry of MNSE Area, Fig. 4).



# More Evidence on a Protohistoric Ceramic Puzzle

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## The Residual Order

I came across the DK-B, C slag in one of the excavation dumps of this section of the compound at the end of April 1984. The importance of the piece lies in the substantial amount of information it provides on the employment of saggars in stone-ware bangles' production, according to the hypothetical models outlined in a contribution presented in the first volume of our Interim Reports (Halim and Vidale 1984: 91-95). Since the very moment of this fortuitous (?) find it was clear that it provided good ground for testing our previous interpretations.

Our field season was over, all our equipment packaged. I couldn't take a single photograph of the piece that was stored in the Moenjodaro Museum Reserve Collection. The documentation work on which this report is based was effected by the writer during a brief stay at Moenjodaro in February-March 1985.

The piece (Figs. 1-2) is a rough polyhedral block, 23 x 19 x 13,5 cm., whose surfaces are, to a large extent, determined by fractures. It is composed by several different elements joined together by the collapse pressure in state of incipient melting, and it bears, in correspondence with the elements' contact surfaces, substantial voids preserving part of the original morphological features.

The collapse producing the slag mass has been described as a disordering process. In the slag the disorder is incomplete; the analysis of its inner components still provides good insights on the collapse dynamics and, as a consequence, on the original setting of the kiln load's elements. In other words, we are dealing with a true sub-primary archaeological deposition. In this perspective, it was decided to describe the piece enhancing its character of complex, "stratified" archaeological context. In Fig. 2 a frontal and a side view of the object have been selected and reproduced like two archaeological guide-sections, with the purpose of delineating the sequence of depositional events producing the slag formation. This procedure has been followed in spite of the evident divergences, both physical and relational, existing between such ceramic deposition and a more common sedimento-archaeological context. These divergences will be encountered all along the piece's description. A first, immediate problem, rather unusual in a normal archaeological section is orientation: one handles the slag and can't figure out in which position should it be placed to restore its original collapse setting, as no technological element or gravitational feature is immediately clear enough to give reliable indications. The orientation of the piece in Fig. 2 (arbitrarily) depends upon pre-existing functional models, as a

## Disorder

Interior of a kiln in the town we now call Moenjodaro, about 4000 years ago. The chamber is heavily breathing heat waves, maintaining the inner temperature around 1000° C, floating around the carefully arranged elements of the kiln's load. Suddenly, an error in the fuel alimentation or in some other particular of the extremely sophisticated organization of the firing system results in a violent rise of the temperature to more than 1100° C<sup>1</sup> in a restricted sector of the firing chamber. The ceramics so painstakingly formed, dried and piled together with the interspacing elements instantly begin to soften, soon reaching a plastic state. The piles start to fall one after the other, pulling down piece after piece the surrounding arrangement toward the overheated core, where they melt like wax into an amorphous bubbling mass. Part of the elements, not directly affected by the burst, fall down still partially maintaining a shape. At the end of this small protohistoric catastrophe, the floor of the kiln recalls some bizarre, proteiform blackish sculpture.

We don't know to what extent such a view could stimulate the aesthetic appreciation of the potter, who had to destroy the glass-hard formation by breaking it with strong blows in order to re-utilize the lower part of the infrastructure or, perhaps, to resign himself to start constructing a new one. We know that, no more than fifty years ago, the remains of the kiln or the pieces of the slag mass were unearthed by the workers excavating the DK-B, C sections of Moenjodaro, just to be discarded on the spot by the modern archaeologist looking for something far more exciting than a black piece of burnt clay.

fragmentary pile of three partially melted pottery bangles has been orientated at the base of the block (Halim and Vidale 1984: Fig. 63).

This orientation has also the advantage of presenting part of the superimposed elements in a sub-horizontal arrangement, like in a normal stratigraphy. Given the irregular nature of the piece, it will be observed that, in the following description, attention is rather freely focussed on whole ceramic components as well as, sometimes, on surfaces having distinctive technological features.

The following discussion of the slag's components is more descriptive than analytical, providing the basic points on which the subsequent interpretations will be founded.

- (1) Fragmentary slag element, strongly bubbled, adhering to the underlying surface (2) with a possible functional surface. The remaining portion has now a lens-shaped section (Fig. 3).
- (2) Vitrified chaff-tempered surface, in which the burnt vegetal particles created a network of angle-like structures, very fragile and easily attacked by salt (Fig. 3). This surface characterizes, in all the observed cases, the outer coating of the saggars called "Coated Carinated Jars" (CCJ) (Halim and Vidale 1984: 65; Figs. 5, 6).
- (3), (4), (5) Layers with sub-horizontal, slightly undulated setting, having uniform structure, with very scarce macroscopic inclusions. (4) and (5) show a strong increase in pores and micro-bubbles often assuming flat elongated shapes, expressing the tension-squashing lines affecting the ceramic walls in the collapse. The three formations are deeply penetrated by irregular cracks. (3) apparently had been formed by the melting of the chaff-tempered coating with the relative CCJ inner wall. The lower section of (3) is compact and hard enough to recall the wall features of these latter saggars. All the three episodes are substantially very similar and could suggest the same formation dynamics (Figs. 3, 6).
- (6) This element, mainly visible in the side view of Fig. 2, is formed by the partially melted wall of the saggars previously defined "Coated Sub-cylindrical Bowls" (CSB), whose association with stoneware bangles' firing had already been ascertained (Halim and Vidale 1984: 91-95). In this case, the deformed wall (6) (Fig. 4) is squashed against the wall of the remains of the up-turned CSB (7). (6) still locally retains the outer coating features, while in the upper parts, in contact with (5), it almost completely loses any shape, transforming into an amorphous bubbled mass (Fig. 4).
- (7) This formation is produced by the outer chaff-tempered coating of the CSB (8) — (9) (Figs. 4-6). It apparently covers the whole saggars; it is distinguished from the superimposed formation (5) due to the circular shape of the inner bubbles (indicating absence of tensional stress) as well as by a darker hue.
- (8), (9) Wall and lid fragments of CSB still retaining part of their morphological features and their primary setting (Figs. 5-6). These elements, unaffected by major distortion like the similar episodes (12), (14), (16) conform to the (morphological) and textural characteristics already described for CSB fragments in the already mentioned report. It is actually possible that at least part of the CSB fragments recovered on the surface were detached from similar slag pavements.
- (10) Apparently in horizontal contact with the group (7), (8), (9) and with the fragment (11), (12) this element is the remaining portion of a CSB showing the distinctive features of the outer coating. The fracture surface reveals an undistinguished bubbled mass (Fig. 6).
- (11) Fragments of outer coating adhering to a CSB wall (Fig. 6).
- (12) Fragments of CSB joining the outer coating of (8) — (9) with (10) (Fig. 6).
- (13) Outer coating of the best preserved CSB. In the area of contact with (7), the outer coating of CSB (8) — (9), the limit between the two elements is hardly recognizable. (13) is well visible all over the exposed sections of the saggars (Figs. 4, 5, 7).
- (14), (15), (16) The first element (14) is a fragmentary up-turned CSB, preserved for something more than one half of the total, showing a slightly S-shaped contour (cf. Halim and Vidale 1984: Fig. 67, i-l). The saggars is still assembled in its primary setting with the fragmentary lid (16), thus enclosing the couple of superimposed stoneware bangles (15) (Figs. 4, 5, 7). Both the saggars and the lid show a strongly concave profile. This feature could well have been enhanced by the collapse pressure, but analogous pieces were recorded from the surface (Halim and Vidale 1984: Figs. 72, d; 74, d). The two bracelets share the same ovoidal section; looking at the fracture surface, the contact between the bracelets appears to be marked by an almost indiscernible line, running across a material strikingly homogeneous from the textural view point. The CSB elements (13) — (16) seem to be placed directly below the upper CSB (7) — (9).
- (17), (18) Remains of other two CSB documented by the usual chaff-tempered outer coating. (17) appears heavily squashed from the upper weight of the series (7) — (9) and (13) — (16); (18), exactly like (10), present an undistinguished bubbled material on the fracture surface (Fig. 7).
- (19) Homogeneous, thick layer intensively bubbled, looking analogous to the episodes of the series (3) — (5) (Fig. 7).
- (20) In phase of incipient melting, this thick compact formation is characterized by a still recognizable

granular texture and by a scarce presence of bubbles. Its inner structure, showing an irregular superimposition of sheet-like formations, recalls the base part of *CCJ*, hand-formed by pressing sheets of clay into a chuck (*Halim and Vidale* 1984: 81). Stratigraphically, this element is directly in contact with (4) and, perhaps, in phase with (5) (the exact nature of the contact with this latter formation is hardly definable) (*Fig. 2*, dashed line).

- (21), (22) These episodes, morphologically analogous to (19) as well as to the upper series (3) — (5), are distinguished on the side view of *Fig. 2* by a noticeable thickness, produced by an intensive thermal dilation, combined with inner circumvolutions. Such a structure is produced by the collapse and the folding of a melted ceramic wall, pushing and covering the group of *CSB*. (22), having a chaff-tempered surface identical to the one described for (2), would correspond to the upper element (3) (*Fig. 8*).
- (23) Chaff-tempered coating with angle-like surface structures identical to the ones described in (2), defining the episode (22) as a surviving portion of *CCJ* wall (*Fig. 9*).
- (24) A series of at least three superimposed terracotta bangles sticking to the surface (23), recalling the base arrangement of *CCJ* in primary setting. The small pile of bangles appears to have been disturbed by external additions, distortion, melting and breaking (*Fig. 9*).
- (25) This unit represents the final, "static" output of the collapse sequence, in the form of a strongly vitrified, dropping surface (*Fig. 9*) generated by the melting of an area immediately close to the piled bangles (*Fig. 8*). It indicates a prolonged, direct exposure to the main heat source; on the other hand, the dropping direction offers the only one indication on the "absolute" orientation of the block in the context of the collapse. Judging from the small surviving vitrified area, as the clay drops are falling in the same direction of the bangles' diameter, the pile could have been reverted; as a consequence, the row(s) of *CSB* containing the stoneware bangles were possibly scattered over a sub-horizontal, irregular surface.

#### Back to the Order?

The best preserved *CSB* visible in *Figs. 4, 5, 7* shows the firing module of a pair of stoneware bracelets in primary context, confirming the model previously hypothesized

after the evidence provided by some bangle pieces bearing remains of the base of the saggar (*Halim and Vidale* 1984: *Figs. 71-72*). The morphological and dimensional features of the saggars, in spite of the heavy distortion, conform to the specimens previously described, whose height allowed the insertion of a number of bracelets ranging from 2 to 4-5. The number of 2 attested by the DK-B, C slag would match with saggars having dimensions analogous to the bowls illustrated in *Fig. 67, e, i, l* of the above mentioned report and it is rather close to the number of 3 we formerly estimated as an average value.

A new particular revealed by the *CSB* (13) — (16) is the strongly concave profile of both the lid and the base of the saggar. In this case, such a feature could have been designed to keep more safely in place the two bracelets after the saggar was closed. A datum contradicting the evidence we previously gathered is the presence, all round the *CSB*, of a continuous outer coating, completely covering the vessel from the lid to the bottom, as well as of a lid for every observable *CSB*. If the bowls had to be piled one over the other, this would have determined an additional coating-and-lid diaphragm between vessel and vessel.

As a matter of fact, a fragment of a *CSB* pile recovered in AA. 28 (*Halim and Vidale* 1984: *Fig. 72, c*) has shown a case of direct superimposition of the bowls without any lid of chaff-tempered coating. These divergences should be ascribed to a certain range of technological variability already observed in other features of the saggars' assembling system (*ibidem*: 84).

The analysis of the slag revealed that the described *CSB* is only one element of a more complex relational aggregate. The diagram in *Fig. 10* shows the relationship of superimposition existing among the various components of the slag, as they appear from the graphic representation of *Fig. 2*. According to our reconstruction, the block contains the residual evidence of not less than 7 *CSB*. A relationship of direct superimposition may be observed in the sequence (17) and (18), (13) — (16), and (7) — (9), to be interpreted as the residue of a cylindrical pillar of superimposed *CSB* fallen down and partially melted in the collapse. Containers (10) and (11) — (12) on one side and (6) on the other one appear now in horizontal contact with the upper group (7) — (9). Do they represent the upper section of the pillar displaced by the collapse or do they belong to some contiguous series? The simple inspection of the slag can't provide a reliable conclusion; the number of *CSB* present in the block (if the estimate is correct, given the intense distortion of the pieces) would somehow point to the second alternative.

As stated above, the pile of *CSB* fell probably down over a sub-horizontal surface. The humped profile of the bowls in the main row would suggest, moreover, that the falling pile crashed down onto an underlying body. The central axis of the piled terracotta bangles (24), adhering to the outer chaff-tempered coating (23),

results displaced of about 90° from the inner axis of the fallen row of saggars.

In the diagram of Fig. 10 it may be observed how the CSB cluster by series of folding episodes (4), (5), (19), (20), (21)), rather homogeneous from the morphological viewpoint; the element (20) may hypothetically be referred to the features of the basal section of CCJ. The parallel series (2) — (3) and (22) — (23) have been interpreted as fragmentary traces of outer coating of CCJ, locally retaining residues of the suspensory bangles forming the basal supporting system. All this evidence points thus to the following interpretation: the collapse of the kiln's load produced pillar(s) of CSB embedded, in melting, by walls and bottoms of CCJ. This would implicate two possible alternatives: either the pillars of CSB were placed in the kiln's chamber side by side with the larger CCJ, or they were inserted *inside* these latter saggars. The diagram of Fig. 10 expresses this hypothesis, taking into account the possibility that the two parts of CCJ outer coating visible on the edges of the block actually belonged to the same coated container. The discussed evidence leads to the hypothetical reconstruction visible in Fig. 11.

A pillar of 5 superimposed CSB, each containing 2 stoneware bracelets, externally chaff-temper coated, has been inserted in the hypothesis of reconstruction of CCJ assemblage (Halim and Vidale 1984: Fig. 62). The characteristics of the inner CSB pillar are directly resumed from the DK-B, C slag. The main problem lies in the modular features of the pillar: in the reconstruction I have assumed for the interior of CCJ an available space of about 15 cm. of diameter x 30 cm. of height, in which 5 assembled units 6 cm. high have been arranged. As the bowls' dimensions are rather variable, the presence of 5 CSB and, consequently, the total number of 10 stoneware bracelets per sagger is wholly conjectural, although my estimates would deny the possibility of the presence of more bowls in such a restricted space. The apparent occurrence of 7 CSB in the block, calling for an external explanation, forms thus an anomaly in the proposed reconstruction. On the contrary, the function of the supporting cones E-F, which could hardly be understood in the framework of our previous model, as the cones can't stand any weight from the closure apparatus (Halim and Vidale 1984: 84), could better be explained with the aim of centering and fixing the pillar to the CCJ walls.

Lastly, it remains to discuss the controversial point of the greenish deposition recovered in 1982, apparently in primary context, on the bottom of one of the complete CCJ specimens (*ibidem*: 89). Again, we still have no safe ground for discussion. We are actually planning to re-analyze samples of the recovered material eliminating all the components which could be ascribed to post-depositional contamination. If we should get, in future, clear evidence of any type of raw material being fired inside the larger saggars, this would noticeably weaken the reconstruction hy-

pothesis of Fig. 11. Any other statement on the subject closely depends upon the developments of the archaeological research.

The DK-B, C slag has demonstrated the primary association of CCJ with CSB, confirming the constant association between the two types of indicators observed on the surface of the relative activity areas. In this perspective the hypothesis of functional connection resulting from this paper appears to have, at the present stage of the research, normative character: in spite of its unconventional, labyrinthine complexity it accounts for most of the observed and/or intuited regularities. I don't think it will be possible to continue to play with the puzzle without re-opening the lid of the box, i.e. to go back to the field and look directly to the stoneware-firing kilns *in situ*.

## Footnotes

- 1 (Schneider and Büsch 1984: 127).

## Bibliography

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Fig. 1

Fig. 1 Moenjodaro, DK-B, C dumps. View of the slag with the Coated Sub-cylindrical Bowl enclosing the stoneware bangles in central position.



Fig. 2

Fig. 2 Front view (left) and side view (right) of the DK-B, C slag. The two views of the object are considered like sections to describe the relationship of superimposition among the inner components.

Fig. 3 Close up view of one extremity of the slag showing a fragment of chaff-tempered coating (2) characteristic of Coated Carinated Jars under an allocthonous element (1).

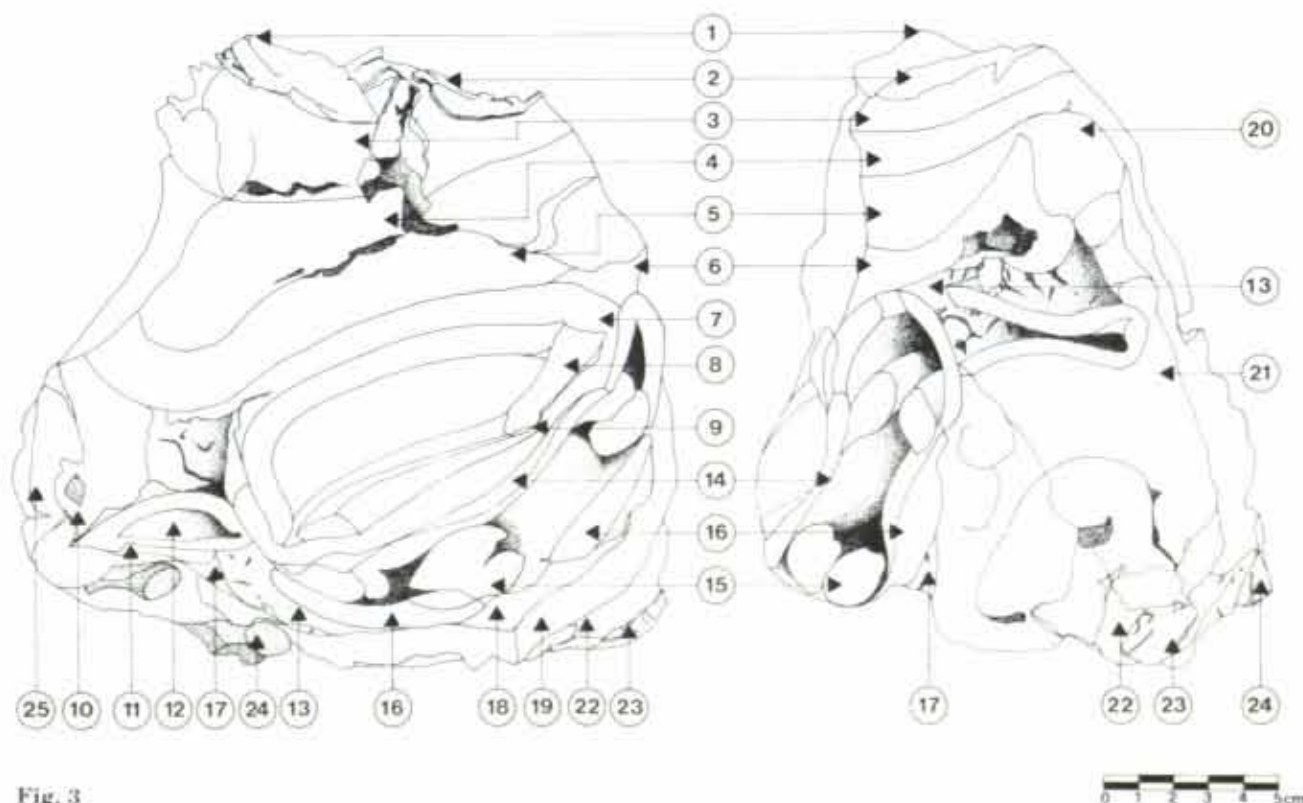


Fig. 3



Fig. 4



Fig. 5

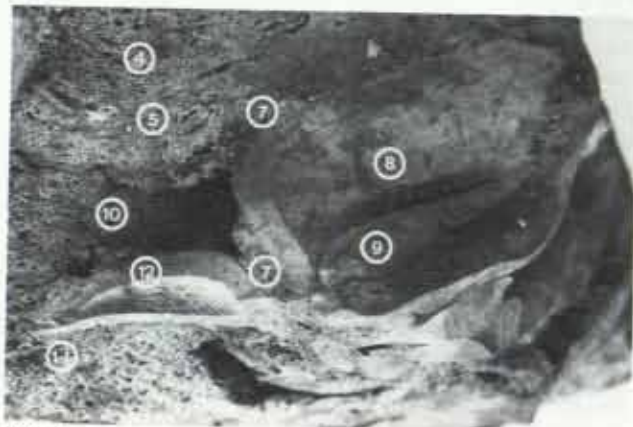


Fig. 6

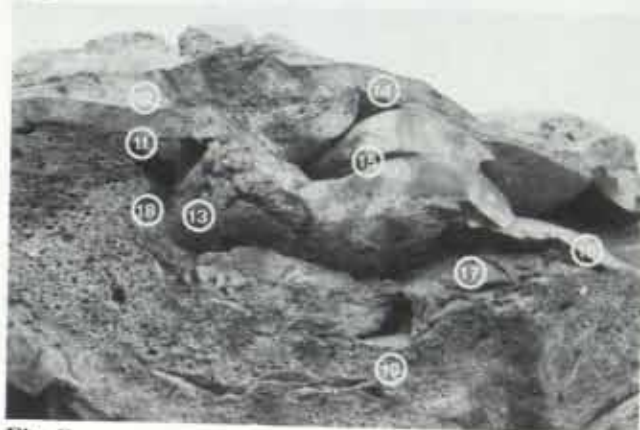


Fig. 7



Fig. 8



Fig. 9

**Fig. 4** Side close-up view of the CSB retaining the stoneware bangles, showing the position of the partially melted CSB (6) in horizontal contact and in partial superimposition.

**Fig. 5** Front close-up view of the central CSB. Note the concave profile of both the lid (16) and the bowl (14).

**Fig. 6** Close-up view of the CSB (7) — (9), showing the horizontal contact with CSB (11) — (12) and (10).

**Fig. 7** Close-up view of the central CSB, showing the position of the lower elements (17) and (18), strongly squashed and transformed into a shapeless mass.

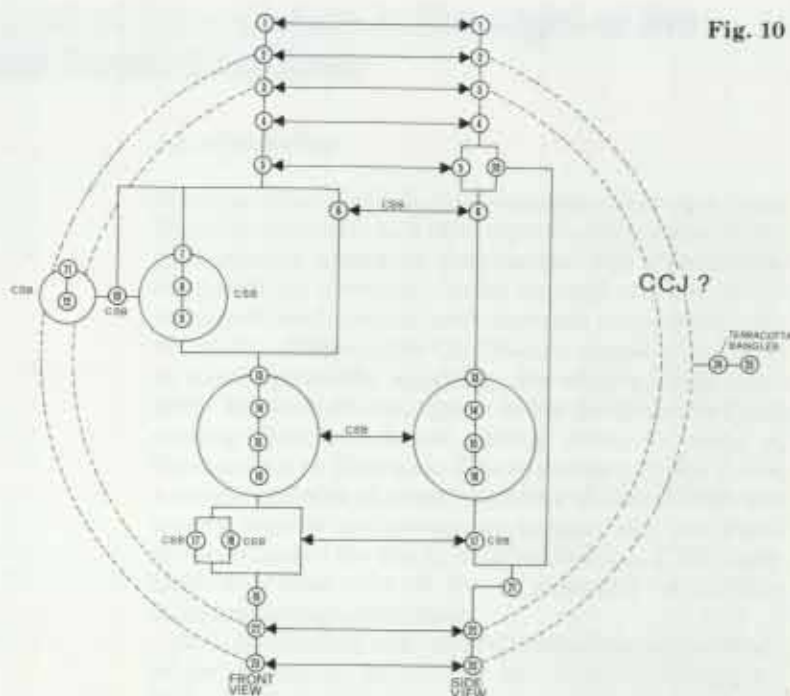
**Fig. 8** Close-up view of three fragmentary terracotta bangles (24) piled and adhering to the outer chaff-tempered coating portion. Such a feature is distinctive of the basal supporting system of CCJ. Note, like in the case of Fig. 1, the presence of external additions deforming the piled bangles' structure.

**Fig. 9** Close-up view of the opposite face of the bangles' pile in Fig. 8. Note the position of the third bangle, partially removed from the pile, as well as the melted clay whose dropping direction demonstrates the sub-horizontal setting of the block at the end of the collapse.

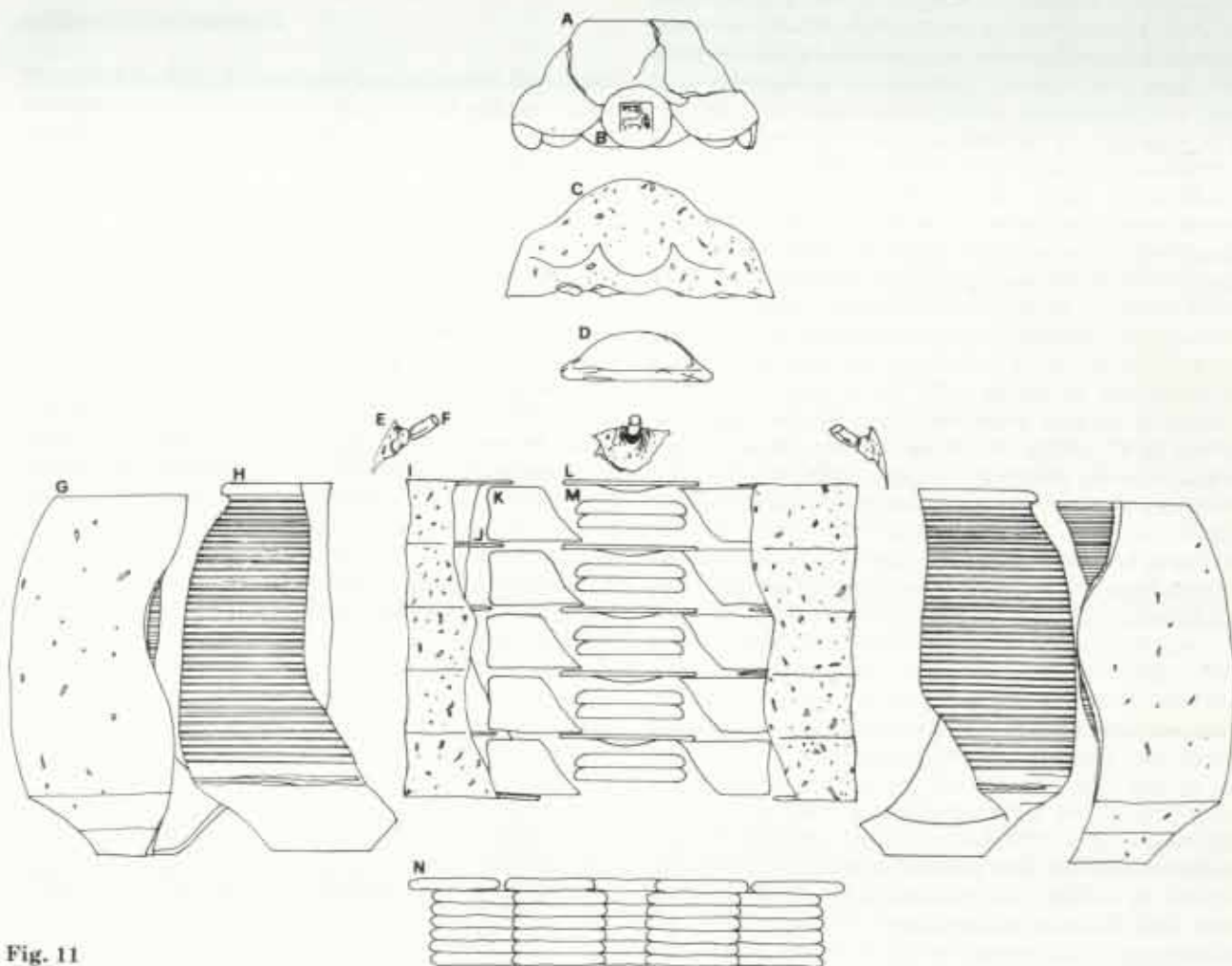
**Fig. 10** Diagram showing the relationships of superimposition among the elements enclosed in the DK-B,C slag. Arrows mark relationship of identity between stratigraphic elements occurring both in the front as in the side view of the piece in Fig. 2. The dashed semi-circumferences express the hypothesis that the fragments of chaff-tempered coating retained by the block have to be ascribed at the same CCJ.

**Fig. 11** Reconstructive hypothesis of the stoneware bangles' firing apparatus in the light of the DK-B,C slag evidence.

- A: upper capping;
- B: sealing with unicorn stamp seal impression;
- C: intermediate chaff-tempered coating;
- D: pottery hemispherical lid;
- E: chaff-tempered supporting cone;
- F: fragmentary, re-utilized terracotta bangle;
- G: red-slipped, chaff-tempered outer coating;
- H: Coated Carinated Jar;
- I: chaff-tempered outer coating of the Coated Sub-cylindrical Bowls pillar;
- J: intermediate chaff-tempered diaphragm;
- K: Sub-cylindrical Bowls;
- L: lid;
- M: stoneware bracelets;
- N: network of supporting terracotta bangles.



**Fig. 10**



**Fig. 11**



# Some Aspects of Lapidary Craft at Moenjodaro in the Light of the Surface Record of the Moneer South East Area

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## ACKNOWLEDGEMENTS

This contribution, like our previous papers on Harappan technology and craft production, would not have been possible without the help of the Department of Archaeology and Museums of Pakistan, whose staff continuously supported our research; once more, we would like to thank M. Ishtiaq Khan for his generous assistance to the German-Italian Joint Project, as well as to Mr. Kurshid Hasan and all the other members of the Department.

A particular thank is owed to our German colleagues, whose constant cooperation was determinant for the accomplishment of the surface survey in the Moneer site. A. Ardeleanu-Jansen provided me with her precious experience of work in the Moenjodaro Museum collections, helping me in finding and recording a substantial amount of information. I have a great debt of gratitude with J. M. Kenoyer, who worked with us at Moenjodaro in the 1983 season. His experience in the field of semiprecious stone-working was for me a primary source of information. Equally important for the present research was the chance of visiting together with Mark and K. Bhan of the University of Baroda the factories of Cambay in Gujarat, for three days, in winter 1983. Many of the interpretations in the paper must be viewed in the background of this brief but unvaluable experience of "living archaeology". A special debt of gratitude is owed to G. M. Bulgarelli, for her precious suggestions and her kindness in answering my endless night questions on lithic technology. Much aid and information was provided by M. Tosi. Many thanks, finally, are due to L. Bondioli, O. Volpicelli, P. Colarossi for the computer elaborations.

## 1.1. Introduction

The trenches dug by N. G. Majumdar in Mounds I and III of Chanhudaro in February 1931 (*Majumdar* 1934) were mainly aimed to demonstrate the Chalcolithic nature of the new site. Going through the list of the recovered artefacts, the archaeologist acquainted with the study of Harappan Civilization immediately feels at home: generally speaking, the objects (*Majumdar* 1934: 40-44) could well figure in the inventory of finds coming from any house, filling, street or dump of Moenjodaro or Harappa. The occurrence in the list of a single unfinished stone bead and of some chert and copper tools is not enough to suggest any particular involvement of the site in craft production. If Chanhudaro was later selected for an extensive excavation it was otherwise motivated.

E. J. H. Mackay arrived at Chanhudaro on the wave of an increasing interest in the study of Harappan technology; to remain close to the subject of this paper, one could easily point out his growing attention to the stone-working technology measuring the space devoted to bead-making respectively in the 1931 and 1938 reports. The Chanhudaro finds represented the most indicate ground for testing Mackay's experience. The excavation report (*Mackay* 1937; 1943) evidenced how a greater part of the structures in the main mound (Mound II) were somehow connected with an intensive form of semiprecious stone manufacture, in particular with bead-making; a striking concentration of rough material, tools, waste and unfinished products found in close proximity with a complex firing infrastructure even suggested the presence of a "bead factory" (*Mackay* 1943: 41-44). The study of the collected materials, where much attention is paid to such a sophisticated artefact as the so called "long barrel-cylinder carnelian beads", includes an exhaustive reconstruction of the transformational chain partitioning the beads' manufacturing cycle. Its inner stages are clearly defined and critically connected to sets of tools and replicative hypotheses on their employment, as well as to the relative range of possible misproducts and wasters (*Mackay* 1937; 1943: 210-214). In the first report (*Mackay* 1937: 7) we are informed that a very distinctive type of drill, already found at Ur where it had been uncorrectly interpreted as an unfinished bead, was used to perforate hard stone beads (the error, shared in the beginning by Mackay, was due to the shallow circular depression visible on the tip of the tool -cf. *Mackay* 1943: Pl. LXXXVI, a, 5). These sub-cylindrical drill-heads, together with the less specialized micro-drills on blade support so common in several 3rd millennium BC bead-making assemblages, were destined, in the long run, to become the archaeological

markers of the ancient lapidaries in the protourban centers of Southwestern Asia.

If we stress the importance of Mackay's work it is because it provided the basic hardware underlying any future perspective of integrate analysis of lapidary craft in protohistorical contexts. He was able to show that one of the most important craft specializations across the protourban systems of the great alluvial plains was fully evident through the traces it left in the archaeological record; and, implicitly, that the effected correlations between archaeological craft indicators and stages of production could grant some degree of control on the qualitative/quantitative parameters of the processual chain of the manufacturing cycle. On a wider perspective, this aspect of craft specialization, conceived, according to G. Childe's (1950) paratactic mode, as a discriminant variable of protourban systems, could be experimentally observed on the field (e.g. Tosi and Piperno 1973: 5).

The Chanhudaro reports, due to the striking amount of information and the relatively systematic treatment of the data, had to remain for a long time an isolated achievement, in spite of the fact that, in Mesopotamia, microlithic industries had been already noticed in Chalcolithic contexts (Watelin 1929: fig. 5). In the following period, K. Butzer (1959) drew attention to some flint drills and related semiprecious stone assemblages which had been found at Hyerakompolis, in Predynastic to Old Kingdom contexts; Soviet scholars studying the Sub-Neolithic Kel'Terminar in the Kyzyl Kum came across intensive evidences of working floors or ateliers where turquoise beads were manufactured (Vinogradov 1972; 1973; see the literature reviewed in Tosi 1974). The geographic mosaic of 3rd millennium BC semiprecious stone working was enlarged to comprehend Mesopotamia, Egypt, Central Asia and India.

The main gap in the picture was still represented by the Iranian Plateau. In 1967-68 took place the first field seasons of Tepe Yahya and Shahr-i Sokhta, which had the effect, since their very beginning, to deeply change the face of the protohistory of Southwestern Asia (Lamberg-Karlovsky 1970; Tosi 1968). The extensive evidence of highly specialized steatite-working activities in the Yahya IV B levels (Lamberg-Karlovsky 1970: 34-82; Lamberg-Karlovsky and Tosi 1973: 33-34) the early recovery at Shahr-i Sokhta of a gem-cutter's hoard (Tosi 1969: 371-373), and, above all, the information gathered from the EWK-EWP activity areas for lapis lazuli, carnelian and turquoise bead-making (Tosi and Piperno 1973; Lamberg-Karlovsky and Tosi 1973: 27; Tosi 1974; 1974a) threw light on the nature of the complex system of distribution and exchange linking Iran and its surrounding regions to lowland Mesopotamia, as well as on the processes of work specialization and social differentiation taking place within the social systems of the plateau centers.

The massive amount of data from prehistoric Sistan

allowed an extensive survey of the lapidary craft evidence in the town and in its suburban settlements, leading, as a basic achievement, to the detailed reconstruction of the manufacturing cycles of beads of different semiprecious stones: lapis lazuli (Tosi and Piperno 1973; Bulgarelli and Tosi 1977); turquoise (Tosi 1974; Bulgarelli 1981); chalcedony (Tosi 1973; Bulgarelli and Tosi 1977). It was possible, moreover, to study the tool-kits related to the manufacturing cycles, including a large number of sub-cylindrical drill-heads analogous to the ones found by Mackay at Chanhudaro, with the result of partially correcting some of his previous interpretations (Piperno 1973; 1981). Recently a microscopic analysis of a set of beads from Shahr-i Sokhta and Tepe Hissar of different materials further enhanced our knowledge of the beads' forming process (Gwinnet and Gorelik 1981).

The evidence from the settlement was complemented, in the Shahr-i Sokhta record, by the graveyard finds. Grave 77, the burial of a chalcedony and calcite bead-maker (Piperno 1976) is an ideological representation of the craftsman status in the contemporary society. Such a burial closely recalls analogous finds from the Royal Cemetery of Ur (Woolley 1934: 206-207). By comparing Grave 77 with Grave 12, being probably the burial of a lapis lazuli and turquoise cutter, Piperno (1976: 12) could hypothesize the existence of a well defined social differentiation between craftsmen processing imported materials to be traded on the international routes and those producing commodities whose raw materials were locally available, and were locally consumed.

The interest arisen by the Shahr-i Sokhta results is partially reflected in the later joint Tepe Hissar Project, and particularly in the surface survey of the craft activity areas of the site (Bulgarelli 1974; 1979). The work at Hissar revealed the presence of a highly specialized lithic complex, including large amounts of flint micro-drills and other types of tools and wasters functionally connected with lapis lazuli bead-making; this craft activity was apparently carried out across widespread sections of the town (Bulgarelli 1979: 42) according to a possible pattern of relatively decentralized small workshops. A second important development was the surface survey effected on the site of Shahdad (Salvatori and Vidale 1982), where a brief survey of the settlement area was enough to show the existence of striking surface pavements of metal smelting wasters and chalcedony bead-making debitage and tools. I remember surfaces littered with thousands of drills and carnelian disc-bead misproducts, suggesting the presence of true "bead factories".

The subsequent cessation of field activity in Iran in 1978 prevented us from testing many important working hypotheses, so furthering the development of our methodological propositions.

We may state that, by the end of the seventies, the body of information and experience so acquired had

given rise to a wide set of models concerning the structural logic of craft production, its material representation and its quantitative evaluation through the archaeological record (Tosi 1984; cf. Vidale 1983). This experimental theoretical framework, finalized to the analysis of the degree of control exerted by the elites of the centers over the craft production sphere during the evolution of the protourban structures, required obviously large-scale contexts of observation. The surface approach, allowing a comparatively rapid processing of large sections of the site, and being relatively inexpensive and non-destructive, appeared to be the most suitable tool of data recording and analysis. Its testing in the eastern Iranian sites, where wind deflation is the main post-depositional variable, investing the surface formations a sub-primary relationship with the original archaeological deposit, had been fairly satisfactory.

These introductory remarks had the purpose of illustrating the premises underlying our new phase of work in Sind. Following earlier field observations by M. Jansen and M. Tosi at Moenjodaro in 1980-81, the Surface Evaluation Program (SEP), jointly carried out by the RWTH-IsMEO team, took place in 1982, with a first objective to survey and record the craft activity evidence directly available on the surface of the archaeological compound as a whole, and with the ultimate, ambitious goal to spread light on the structure of the craft production originally operating through the system (Bondioli et al. 1984: 13-14).

The first two seasons of field research at Moenjodaro were obviously far from being exhaustive enough to allow any reliable conclusion. But the pattern emerging from the preliminary maps seems to present some significant divergences from the eastern Iranian sites. The large workshops and craftsmen quarters of Shahdad seem to be replaced by a scattered network of small productive cells, whose average dimensions would conform to the expected size of a small working floor or to the space occupied by one-two rooms of a normal Harappan house, and exhibiting a strongly discontinuous pattern of relative density of indicators (Pracchia et al. 1985). Such a model would appear to apply to semiprecious stone-working as well. To ascertain whether these possible divergences should be ascribed to an inner difference in the structure of the production system, or to different or alternatives post-depositional phenomenologies will be a necessary step in the development of the surface research at Moenjodaro.

In starting our work, it was decided to effect an intensive/extensive effort on surface recording and interpretation in the so called "Moneer South East Area" (hereafter MNSE Area) (Bondioli et al. 1984: 24-26; Pracchia et al. 1985). As stated on other occasions, the site was selected because of the high degree of concentration of artefacts and the size of the relative area of distribution, allowing the possibil-

ity of extending the technological analysis of the cycles as well as of testing the feasibility of the locational approach within the limited context of a single craft activity area. The present paper deals with a specific aspect of the MNSE Area evidence, i.e. the semiprecious stone-working record, as a further small step in the study of the town's system of craft production. Like a previous paper on the MNSE saggars (Halim and Vidale 1984) this contribution is to be conceived as a part of the preliminary presentation of the field activity carried on in 1983-1984. The analysis is centered on the composition of the MNSE surface assemblage, on the functional relationship existing among the different types of indicators and on the reconstruction of the processual aspect of the manufacturing cycles, against the wider background of the body of data on semiprecious stone-working so far available at Moenjodaro.

## 1.2. Evidence from Earlier Excavations

*"A few unfinished beads were found during the excavations at Mohenjo-daro. Their number was so small, however, as to suggest that though bead-making was a craft practised in that city it was not carried on to any great extent, unless it were in parts of the city that have not yet been explored."* (Mackay 1937: 1).

With this statement Mackay summarized the evidence gathered in the previous large-scale excavations. The Marshall report contains some sporadic references to agate unfinished beads coming from sections DK and SD (Marshall 1931: 144, 526). The inventory of the artefacts attesting semiprecious stone-working within the town's compound is not much longer: it includes two possibly unfinished agate "burnishers" (*ibidem*: 585), a single unfinished semiprecious stone marble (*ibidem*: 553), some "rough nodules" of amethyst (*ibidem*: 526) and some pieces of crystal from L Area (*ibidem*: 170), and a single unfinished chert weight (*ibidem*: 221).

The high standards of Harappan stone-working were first revealed by the spectacular find of the jewellery hoards recovered in DK Area, Trench E and HR Area (*ibidem*: 519-523). These discoveries offered an occasion to carefully examine the stones represented in the necklaces (*ibidem*: 525-526; 534-548). Chalcedony, with its great variability, appeared to be the preferred material (*ibidem*: 509, 525-526). Much attention was deserved to the skill needed by the artisan to exploit the natural banding of the agate geoids, controlling the orientation of the inner micro-layers in relation to the central axis of the bead (*ibidem*: 537). The report, moreover, mentions the artificial treatment of carnelian to improve its red colour (*ibidem*: 509), to decorate the bead with white drawings, as well as a possible technique to produce an artificial black stone (*ibidem*: 526). Discussion on bead-making technology is limited to the description of a sequence skeleton partitioned in four stages: rough shaping by chipping, flaking,

smoothing and boring (*ibidem*: 526). In a separate section of the report is outlined the reconstruction of the manufacturing cycle of stone marbles (*ibidem*: 533). More attention is paid to the long barrel-cylinder beads, and especially to the constraints of the drilling process (*ibidem*: 511, 520), in which, according to Mackay's early interpretations, a copper drill was possibly operated with a lathe, using emery as an abrasive (*ibidem*: 520).

The 1938 report offered to Mackay the opportunity to describe in greater detail a wide range of materials, tools and techniques. The author provides an accurate description on 10 unfinished stone beads (Mackay 1938: 501-502; see *Tab. 1*) with new information on the bead's forming and drilling processes. The reconstruction presented in the previous report is here both confirmed and enlarged upon. He is also suggesting the employment of "grooved" stones in the smoothing phases, although in the published "anvils", "whetstones" and "querns" we do not find any description or illustration of such a type of tool (Mackay 1938: 406-407). In several points of the report it is hypothesized the use of emery or silica abrasives: in smoothing the blanks (*ibidem*: 501, 502) or to shape the composite beads (*ibidem*: 504); in smoothing the hole of the carnelian long barrel-cylinder beads (*ibidem*: 662); and, confirming the old interpretation, with copper drills to perforate the beads (*ibidem*: 502). In spite of the frequent references to the employment of tubular drills in stone-working

(*ibidem*: 320, 323, 397, 399, 402, 411-412, 597) and the publication of two copper drills (*ibidem*: 475; Pl. CXXXI, 6, pl. CXXXII, 10) review of bead drilling technology does not go beyond the previously quoted statement. It is taken into account the possibility that relatively hard stones, notwithstanding the great technical problems, could have been cut with metal saws (*ibidem*: 583). The manufacture of the cube-shaped chert weights, furthermore, is briefly described (*ibidem*: 401).

Lastly, we can add to this scarce inventory of references the following quotation:

*"The discovery of a good number of beads, 16 small weights, a pair of small copper scale-pans together with a fulcrum rod made in a room directly accessible from the lane suggests that this was a lapidary's shop"* (Government of India 1936-37: 41).

The site to which the quotation refers is the DK-I or Moneer site (see also Government of India 1930-34: 51, 72; Dales 1982; Jansen 1984). Nothing more is known about this assemblage, except that the buildings had been excavated only to the upper levels (Government of India 1936-37: 41). The existence of a possible lapidary's shop in this section of the site would match with the evidence of large amounts of steatite wasters on the top of the western dump of the Moneer excavations (J. M. Kenoyer, personal communication, incorporated in Vidale, this volume) suggesting that part of the excavated structures (assuming that "shops" might have been located in proximity of working areas)

**Tab. 1: 10 unfinished stone beads published in the 1938 report**

Field No.	Pl.	Location	Material	State
DK 7692	CXI, 6	7, I, 5; -18,2	light brown agate splashed with white	roughly rubbed into shape, unbored
DK 5085	CXI, 41	3, I, 5; -14,9	black jasper with prominent veins	smoothed, unpolished unbored
DK 5365	CXI, 48	1, IV, 63; -13,7	light gray agate with milky bands and veins	smoothed in the middle portion; ends flaked, untouched; unbored
DK 2824	CXXXIV, 13	Surface	drab-coloured agate veined with white	smoothed, partially polished, unbored
DK 10413	CXXXVI, 7	6A, 41; -5,5	brown and white agate	smoothed, partially polished, unbored
DK 12450	CXXXVI, 8	6A, 41; -9,7	dark-gray agate	smoothed, unbored; ends painted
DK 12757	CXXXVI, 20	9A, VIII, 56; -9,4	dark green agate banded with red and black	roughly rubbed, unbored, possibly artificially coloured
DK 11135	CXXXVI, 28	Central Str., -6,8	white agate veined with brown and gray	smoothed, unpolished; partially drilled at one end
DK 11342	CXXXVI, 37	23, II, 13; -7,5	agate, irregularly banded and veined with brown on a white ground	smoothed, unbored
DK 11316	CXXXVIII, 14	8A, 38; -4,3	chocolate-coloured agate with white ends	smoothed, drilled at one end; partially drilled at the other

could have been involved in craft production. Doubtless, one is tempted to hypothesize a more or less direct connection between the early excavations finds and the recently recorded surface evidence.

After the excavation of the Chanhudaro "factories" a greater part of the obscure points of Mackay's technological reconstruction were solved. The raw material, particularly the plentiful carnelian nodules, are exhaustively described, as the preliminary chipping they underwent to allow the inspection of the inner structure (Mackay 1937: 3). The evidence suggesting thermal treatment of the material to intensify its red hue is considered (Mackay 1937: 3; 1943: 214). It was ascertained that carnelian was then turned into slips and rods by cutting the nodules with metal wires or saws operated with abrasives (Mackay 1937: 4; 1943: 211), a very advanced technique, eliminating the need of a wasteful chipping and leaving the task of forming the rough-outs to a simpler, more regular flaking. The subsequent shaping phases were related to the employment of "bead-stones" (Mackay 1937: 5; 1943: 214), i.e. sandstone blocks bearing grooves with a strong inner polish. Being the grooved stones gritty enough, the need to employ abrasives was denied (Mackay 1937: 5). A third, basic contribution was the extensive review of the drilling apparatus. In the Chanhudaro assemblages were recognized some "ribbon flakes terminating in a point" (Mackay 1937: 5) which could have been used to produce on the blanks the first guide-depression for the subsequent drilling. The same chert borers were used to perforate carnelian disc-beads (Mackay 1937: 9; 1943: 210-211). The disc-bead rough-outs were obtained by sections of the longer slips prepared for elongated beads (Mackay 1937: 9; cf. also Gwinnet and Gorelik 1981: 14). It may also be observed that, in dealing with the perforation of carnelian disc-beads, Mackay described a splintering rather than drilling technique, an intuition recently confirmed by the detailed study of a small atelier at Larsa in Mesopotamia (Chevalier et al. 1982). Finally, in the last reconstructions the copper drills are replaced by the newly identified sub-cylindrical stone drills (Mackay 1937: 6; 1943: 211-212), so completing the outline of the technological sequence. The final polishing process was destined to remain elusive in the archaeological reconstructions (Mackay 1937: 9; 1943: 211).

One of the results of the preliminary phases of the surface survey at Moenjodaro has been to demonstrate that the technological know-how of the Chanhudaro craftsmen was fully shared by the lapidaries of Moenjodaro. The whole range of techniques studied by Mackay seems to be attested by the relative set of indicators, from the grooved stones to the stone slips cut with metal saws and the sub-cylindrical stone drills. But this technological homogeneity has to be viewed on the background of a set of dichotomic differences between the nature of the two sites. The striking concentrations of indicators found in the small

site of Chanhudaro have not yet been found in the major center, in which, as far as we may now observe, lapidary craft was carried out in accordance with a rather disaggregated organizational pattern.

### 1.3. Distribution of the Semiprecious Stone-Working Evidence Across Moenjodaro

Before discussing the apparent distribution of semiprecious stone-working across the site, we have to emphasize that the observable record is produced not only by an abstract ancient cultural pattern, but also by the intervention of a wide, heterogeneous series of external variables that may be collated under the general definition of post-depositional factors. Leaving aside the uniform work of dislocation of atmospheric agents, one of the most important factors may be identified in the dynamic of recollection and reworking of discarded stones in the framework of the production cycle itself. At Cambay, the Gujarati town still famous for its bead-making factories (Arkell 1936; Trivedi 1964; Possehl 1981) smaller and lower-quality stones are progressively recollected from the abandoned heaps till the market can absorb less valuable products or simply requires smaller beads (J. M. Kenoyer, personal communication). To this form of reworking, accomplished through further physical reduction, must be added possible forms of recycling through the intervention of more complex physico-chemical transformations, like in the case of the silica material ground into powder for faience-related industries (Vidale in this volume). Secondly, the representation of the relative incidence of the different stone varieties in the archaeological record is a direct function of the stones' resistance to weathering and decay (Bondioli et al. 1984: 19-21). Silica stones often bear strongly altered, whitish surfaces, but they appear to be successfully attacked by salt only in presence of pre-existing heat-caused crackings. Softer stones, in first place steatite and limestone, are definitely much more perishable; serpentine appears to be rather resistant in spite of its moderate hardness, while turquoise, very rare at Moenjodaro, is notoriously prey to damage from oxidation. Finally, surface distributions may have been deeply affected by other cultural noise sources such as the practice, apparently still very common in Sind, of collecting chalcedony-agate fragments and objects to turn them into "akik", considered a very healthy and precious medicine (Sher and Vidale 1985).

The map reproduced in Fig. 1 summarizes the most relevant evidence provided by the excavation reports and gathered with the first two seasons of the SEP up to March 1984. As one could have observed in reviewing the existing literature, the available information is absolutely scarce and episodic. For what concerns the surface survey, the present estimates must be considered only preliminary. Activity Area (AA) 40 is by far the most substantial concentration so far discovered at

Moenjodaro (Bondioli et al. 1984: 24; Pracchia et al. 1985); it is followed by the small AA 1 and 3, presenting semiprecious stone lumps — flakes — bead blanks associations. We expect that similar small AA shall be much more numerous at the end of our research. AA 1 and 3 were detected by a very close inspection, observing the surface from a 20-40 cm. distance, after a series of areas had been randomly selected at the beginning of the survey.

Symbols *b*, *c*, *d* in Fig. 1 represent respectively the surface find of minor concentrations with bead blanks, large unexhausted of defective chalcedony blocks (see Figs. 13-14) and minor clusters with semiprecious stone flakes and (defective) rough-outs. The resulting picture leads us, again, to a specific dimension of the disaggregated model of craft organization we have previously mentioned. Lapidary craft would have been practised in different sections of the town including the Citadel, a pattern consistent with that observed for deeply different specializations, such as shell working (Kenoyer 1984: 105-108) or stoneware making (Halim and Vidale 1984: Fig. 8). On the other hand, we repeat, it is still quite possible that a large "bead factory" would be revealed either by an intensification/extension of the survey or by further erosion of the site surface.

There is an independent research approach which could provide substantial light in the subject: the systematic effort by the RWTH team to relocate the 38.000 entries in the original excavation registers into the architectural context (Ardeleanu-Jansen et al. 1983)<sup>1</sup>. Once this task has been accomplished, we should have at our disposal a complex diachronical framework of data to be attemptively interpreted. A brief examination of the materials kept in the Moenjodaro Museum and its Reserve Collection clearly reveals that the recovery of semiprecious stone rough-outs, blocks, blanks and debitage (Figs. 2, 3) had to be not all infrequent across the excavated quarters.

## 2.1. Surface Analysis in MNSE Area, 1982-83

The surface recording of the site, enclosed in a rectangular area 60 x 45 m., with a total extension of 2700 m<sup>2</sup>, was accomplished by the end of the 1983 season. The methodology of data collection, involving centimetric localization of artefacts and use of suspended platforms for non-destructive observation of the surface, has been discussed in a previous paper (Bondioli et al. 1984: 21-23). The surveyed area (Fig. 4), delimited by 2820-80 (Long.) and 1235-80 (Lat.) coordinates of the grid system, encloses to the west a portion of the level plateau of the lower town and, towards east, a larger slope section, cut by a series of deep, winding valleys running from west to east. The valleys alternate with series of promontories, corresponding to compact aggregates of structures deviating erosion along the edges, usually formed by fired brick walls

more or less closely orientated according the cardinal points. The main geomorphological feature in the site is the large promontory occupying a central position in Fig. 4. It probably marks a sub-rectangular or trapezoidal structure apparently covering an area of 15 x 25 m. ca., and forms at middle slope an irregular terrace strongly attacked by erosion on four sides. The two west-east oriented valleys bordering the promontory at north and south have particularly steep gradients in correspondence of the contact zone between the upper section of the slope and the terrace; progressive erosion will isolate the promontory, in the near future, as a low, separate hummock. Outcropping of semiprecious stone-working indicators in MNSE Area results closely associated to such a feature; their distribution on surface shows two irregular crescent-shaped clusters, at west and east of the promontory. The dense western concentration marks the zone more intensively attacked by erosion between the upper slope and the terrace edge. The eastern cluster, characterized by an inferior density, is uniformly exposed along the gentle gradient of the promontory facing the lane.

Different sources of information are currently being taken into account to come closer to a definition of the genesis of the surface clusters of indicators, including aerial photography and mapping of the visible structures, as well as sedimento-archaeological mapping of the surface formations variability, carried out by C. Balista and G. Leonardi. As a complementary analytical step we effected a series of experiments of sub-surface inspection, stripping the topmost sediments by forced air to expose the erosive interface. The most important stripping test, involving an area of 15 x 0.5 m., crossed the western crescent-shaped concentration, allowing the recovery of substantial information on the depositional context. These topics shall be discussed in a separate forthcoming report. Forced air cleaning has the effect to expose sedimentological micro-features in satisfactory conditions of chromatic contrast without direct mechanical alteration of their delicate stratigraphic pattern. It was thus possible to gather some evidence suggesting, at this preliminary stage of research, a secondary context of deposition of the lithics, which could have been progressively accumulated along the slopes after their systematic removal from their primary setting on the working floors. This hypothesis will be tested against the evidence provided by the other analytical procedures.

## 2.2. Composition of the MNSE Area Lithic Assemblage

During the systematic recording of the site we found a total amount of 3263 lithic artefacts. Being the surface of an archaeological site the final output of a potentially unlimited set of quite different processes, if we consider that our assemblage is substantially produced by a phenomenology unitary in space and time, we also

expect that it unavoidably includes a certain amount of items produced or discarded in the frame of other synchronical phases of human activity. In this perspective, the present preliminary estimates are biased by the intervention of a certain degree of noise the extent of which shall be evaluated after the locational analyses and the functional study of the tool-kits will be completed.

The artefacts were recorded on the field, and directly entered in an inventory. After the preliminary examination in the SEP laboratories, the materials were stored in the Exploration Branch collections of the Department of Archaeology and Museums of Pakistan, Karachi, where they were classified and codified. Figs. 5 and 6 show the nomenclature of the identified minerals and rocks according to Dana's system (Hurlbut 1959).

The diagram in Fig. 7 represents the relative incidence in the assemblage of all the identified rocks and minerals, while in Fig. 8 the semiprecious stones involved in the manufacturing cycles as processed materials are considered without the other classes. In both the cases, the percentages are calculated by number of recovered indicators.

Chert finds (Fig. 7: about 63% of the total assemblage) amount to 2100 units ca., thus representing the most important class (Fig. 9). The chert recovered in MNSE Area does not differ from the chert so widespread in the other sections of the compound, and it conforms to the basic features described by Kenoyer (1984a: 118-119) in his study of the UPM lithics. A small part of the chert is banded, and few fragments and rejected rough-outs (Fig. 71) should be considered as related to the manufacture of cube-shaped weights and micro-weights (cf. Mackay 1938: 401). The chert assemblage is currently studied by G. M. Bulgarelli, and her work will more specifically evaluate the evidence of functional interrelationships between lithic tool manufacture and their employment in semiprecious stone-working (for an extensive review of the connections between lithic tools and lapis lazuli working at Tepe Hissar see Bulgarelli 1979). We may preliminarily observe that not less than 43% of the chert complex is formed by broken unretouched bladelets bearing no macroscopic evidence of wear, nor extensive edge-damage. If we add to this value the substantial number of drills obtained from chert bladelets (about 240, i.e. 11% ca.) we would have a percentage of 54-55% of the chert items possibly connected with drill-making and employment.

The class "metamorphic rocks" (Fig. 7: about 5%) is almost entirely formed by quartzite flakes, very often in form of small splinters bearing surfaces polished by grinding and detached from quartzite quern stones (Fig. 10). These tools are ubiquitous finds on the surface of Moenjodaro, and should have been widely used in household activities; they were also utilized as bead-making tools, and some recovered specimens show to

have been reutilized with this function after the breakage (Figs. 46-48). The assemblage perhaps contains different types of quartzite, and possibly some varieties of sedimentary quartzite or quartz-arenite, but it is generally difficult to recognize metamorphic quartzite from sedimentary one (Dietrich and Skinner 1979: 196).

A very small amount of flakes and two bead blanks have been identified as metamorphized carbonate rocks and defined as "marble". Metamorphic stones like breccia, conglomerate and marble were commonly used at Moenjodaro for the production of small items such as gamesmen (Marshall 1931: 557, Mackay 1938: 77, 576, 578); balls (Marshall 1931: 553) and beads (Mackay 1938: 498). As a matter of fact, as in the case of quartzite flakes, it is not always immediate to distinguish stones of this class from sedimentary carbonate rocks of more common occurrence, particularly when the fragments are very small.

The assemblage, moreover, comprehends a minor percentage of sedimentary rocks (Fig. 7: 3%) part of which is formed by limestone or limestone-like flakes. An unfinished bead (Fig. 52, c) demonstrates the use of limestone in bead-making in MNSE Area. According to the reports, limestone beads were very popular at Moenjodaro (Marshall 1931: 148, 512, 513; Mackay 1938: 449). Besides beads, the list of the limestone objects includes a striking variety of products: cones (Mackay 1938: 407-408), marbles (*ibidem*: 567), dice (*ibidem*: 560), weights (*ibidem*: 320), seals (*ibidem*: 348), statues and figurines (*ibidem*: 257, 284, 298), mace-heads (*ibidem*: 397-399), jar-stands (*ibidem*: 207, 213, 413), "pedestals" (*ibidem*: 412, 413), ring-stones (*ibidem*: 595-598), grinders and rubbers (*ibidem*: 394, 407), vessels (*ibidem*: 320). The various possible context of utilization of limestone in the form of finished products, including its possible employment for tools, a relative degree of dishomogeneity in the recovered fragments, their small size and strong weathering suggested to rule out from the diagram of Fig. 8 the limestone flakes. The sedimentary rocks include also a group of sandstone artefacts; the employment of sandstone in semiprecious stone-working is demonstrated by the recovery of a large block with bead-smoothing traces (Figs. 49-51), but polishers and shapeless flakes are also on record.

The sub-cylindrical drill-heads were, without exception, obtained from a very distinctive type of chert (Figs. 56-59), which in the literature is sometimes called "phtanite" (see, among others, Jarrige and Tosi 1981: 135). In the 1937 report it is stated that this type of chert contains magnetite (Mackay 1937: 6); its visual inspection suggests the presence of iron-manganese oxides. The small incidence of this very distinctive material in the assemblage (little more than 1%) may refer to its extremely specialized utilization.

The igneous rock group (about 0.4%) is represented by a handful of basalt flakes, sometimes bearing highly polished surfaces, possibly indicating the use of

pounders and pestles.

The other classes represented in the diagram of Fig. 7 are the mineral series utilized as semiprecious stones; in the diagram of Fig. 8 they have been isolated to evaluate their relative importance. The chalcedony group of stones forms the greatest majority of the semiprecious stones recovered on the surface of the site (Fig. 8: 72%), the histograms of Figs. 16-18 illustrate the internal variability of this group according to the identified structural/chromatic varieties. As observed by Tosi (1980: 448) such varieties "can be better classified from a commercial than a mineralogical point of view, as this extreme differentiation contrasts with an absolute uniformity of physical properties. . .". To a certain extent, the names given to chalcedony varieties by a given socio-cultural context depend more upon a set of historically determined constraints than on a system of physical attributes, and this situation may explain the degree of confusion existing among the different adopted classifications and the overlapping character of some typological terms. According to Francis (1982: 2) another source of confusion is to be identified in the extremely wide range of physical and chemical treatments (very often involving pyrotechnological processes) by which it is possible to produce artificially coloured varieties. The nomenclature here adopted (which is simply aimed at describing the variability of the discussed assemblage) results from the comparison between the typology proposed by Bulgarelli and Tosi (1977; see also Tosi 1980) and some terms commonly used in the literature on the Indian beads (see, among others, Francis 1982: 1-2).

Chalcedony is found at Moenjodaro in two different basic varieties: fragments of small, ovoidal nodules ranging 2-10 cm. in diameter (Figs. 11, 12) and radial fragments of larger blocks, bearing, as a rule, wide portions of cortex, and formed, for a significant part of their volume, by the long, irregular quartz crystals contained in the inner cavity (Figs. 13, 14). In both cases the concentric banding characterizing geoid formation is easily recognizable. The first group is by far the most common: the stones belonging to it always present a highly polished cortex, denouncing the secondary alluvial context of extraction of the pebbles. The larger fragments of the second group, on the contrary, have rough, irregular cortical surfaces still bearing traces of the softer calcareous gangue indicating the direct extraction of the blocks, probably in the form of thick veins with an inner concentric core from the mother rock. Furthermore, the two groups appear to be distinguished by their chromatic range, restricted to whitish-bluish shadows for the larger blocks, while smaller pebbles often exhibit brownish, olive or reddish hues. In the MNSE Area we have recovered so far only specimens belonging to this latter group, but, on the other hand, it is not to be excluded that part of the minute flake debitage

(Fig. 15) was detached from larger blocks.

Chalcedony geoids are considered fruit of the deposition of silica gel trapped in gas pockets or bubbles present in lavic formations (Wadia 1983: 119; Tosi 1980: 448; Francis 1982: 2). The distinctive inner banding of chalcedony and, in particular, of agate geoids has been ascribed to the dynamics of discontinuous precipitations of metal oxides captured from the cavity's walls in concentric, locally saturated zones of the colloid filling, in accordance with "Leisegang rings" simulation model (Overbeek 1978: 855-856).

Such formation dynamics are directly responsible for a series of features which are of outstanding relevance in the manufacturing sequences, particularly for the fibrous, coarsely crystalline banded varieties of chalcedony so frequent in the MNSE Area assemblage, in first place carnelian-agate.

Carnelian-agate is the name adopted here to define all the specimens characterized by a yellowish-red hue and a marked internal concentric banding of translucent or white stripes. This term has been preferred to the term "carnelionyx" which (besides being suggestive of strange mythological creatures such as chimeras and manticores) would imply a more regular pattern of banding (Francis 1979: 21, 79). Carnelian-agate represents 63.5% of the total group of banded varieties (Fig. 18, 1) and carnelian forms 44% of the monochrome ones (Fig. 17, 1). The two varieties would thus account for no less than 53.8% of the whole semiprecious stone group (Fig. 16), clearly characterizing the bead-making industry of MNSE Area as oriented towards red translucent varieties, while at Shahr-i Sokhta sardonyx is the most popular banded chalcedony (M. Tosi, personal communication). It is useful to recall that any distinction between monochrome and banded red varieties is based on quantitative more than qualitative parameters: also some of the best carnelian beads show, on closer inspection, a pattern of concentric transparent banding. The term "carnelian" is here intended to define any particularly good variety of red translucent chalcedony, whose translucent or transparent banding does not contrast with its basic shadow. Another possible source of error in this distinction is that, in the case of agates with large bands, small flakes, representing the greatest majority of the artefacts on record, could be classified with the monochrome group.

A series of translucent monochrome specimens has been classified as "whitish chalcedony" and "yellowish chalcedony", in spite of a similar difficulty in drawing a clear-cut line between the two shadows; the same observation may be true also for the less common "grayish chalcedony". The three light-coloured varieties, as a whole comprise, about 47% of the monochrome varieties (Fig. 17, 2-4) and 23% of the total chalcedony (Fig. 16). Other monochrome varieties on record are sard and praze, the brown and light-apple green shadows of chalcedony, but their incidence would

appear rather unimportant (Fig. 16). "Pyroclastic chalcedony" flakes, always in Fig. 16, for a small group to be discussed in paragraph 3.2.

Two varieties of agate recovered in the site were called respectively "whitish-grayish agate, white-banded" and sardonyx (6.8% and 6.3% in Fig. 16), this latter being brown-coloured chalcedony with concentric whitish stripes, a class partially shading into the red varieties. Lastly, we may mention the recovery in a separate subsurface test at the site of some flakes of moss-agate, presenting the very distinctive green dendritic inclusions.

With the term "serpentine" we define a light-apple green translucent stone characterized by a waxy luster and 4-4.5 hardness on the Mohs scale. This stone (Fig. 19) was defined in other occasions as "jadeite" (Bondioli et al. 1984: 24), but in the light of the described features this is probably incorrect, and a proper physical determination is needed. This attractive material forms 2.6% of the whole assemblage (Fig. 7), and approximately 10% of the semiprecious stones group (Fig. 8), being the second stone of importance after the chalcedony group; it was worked into beads and small objects among which we could ascertain the presence of truncated-cone shaped gamesmen (Fig. 35, i).

Jasper, present with flakes, rough-outs and bead blanks (Figs. 20, 21) accounts for about 2% of the whole assemblage (together with the group heliothrope-plasma: Fig. 7) and for 7.5% of the semiprecious stones group (Fig. 8). The recovered jasper debitage exhibits a striking chromatic variability, a circumstance recalling analogous features in the jasper beads found in the excavations (Marshall 1931: 545; Mackay 1938: 499). According to Dana's manual, heliothrope or bloodstone would be a kind of green chalcedony containing small spots of red jasper (Hurlbut 1959: 482). In Fig. 8 the group "bloodstone<sup>2</sup> plasma", accounting for 5.5% of the semiprecious stones, is a rather dishomogenous group of greenish, more or less translucent specimens. Given the difficulty in classifying correctly the very small flakes forming a large part of the debitage, all the green varieties (with the exception of some particularly recognizable fragments of praze) were grouped under this term. Fragments bearing the red spotting of heliothrope are rarely found, but the employment of this stone in bead-making is clearly attested by the recovery of a couple of blanks (Figs. 40, f; 41, c), confirming the popularity of this stone at Moenjodaro (Marshall 1931: 544).

Rock crystal (Fig. 22), accounting 3% in Fig. 8, is represented in the assemblage by a series of small flakes that, sometimes, could be confused with the elongated quartz crystals produced by the breaking of the geoid's inner cavity (Fig. 23). This could have slightly biased the representation of rock crystal incidence across the assemblage. Rock crystal beads, although rather rare, may be found on the surface of Moenjodaro and some-

times occur in the excavation find lists (Marshall 1931: 512; Mackay 1938: 498-499). A single rough-out could possibly suggest the presence of crystal bead-making activities of secondary importance (Fig. 38, f). Amethyst, whose employment in bead-making was not uncommon (Marshall 1931: 526) is represented in the site by a single flake.

Turquoise would be attested in the MNSE Area by a single bead blank (Figs. 41, b; 45). The identification, anyhow, is still rather uncertain; in case of confirmation, the find could be of particular interest, because the use of turquoise at Moenjodaro was apparently exceptional (Marshall 1931: 525). Lapis lazuli is present with one small chip and a single tiny bead blank (Fig. 52, i). Like turquoise this stone would seem to be definitely rare, both in the find lists and on the surface of the town (cf. Marshall 1931: 528; Mackay 1938: 500). If the scarcity of lapis lazuli were to be ascribed to a low consideration of the blue stone in the Harappan world, or to some kind of ideological attitude rejecting it, such a picture would be consistent with recent reviews of archaeological and literary sources on the position of the stone in protohistoric India (Chakrabarti 1978; Buddrus 1980).

Lapis lazuli and turquoise in Fig. 8 are grouped with other materials, such as some marble or limestone flakes and bead blanks and sundry unclassified flakes. The total incidence of this dishomogeneous group in the semiprecious stones assemblages is 1.2%.

We may now summarize the evidence we have reviewed: the MNSE Area lithic assemblage is mainly composed by chert remains, a significant part of which was probably connected with making of drill-heads; "phtanite" sub-cylindrical drill-heads were certainly manufactured and utilized in the area; a relatively large set of indicators in various materials, mainly rocks, may have been produced by the employment of hammering, flaking, grinding, polishing tools<sup>3</sup>; among the worked semiprecious stones chalcedony largely prevails, and, within the chalcedony group, the red varieties are most substantially attested, preceding other monochrome or banded stones; besides chalcedony, in order of importance, we meet serpentine, the jasper-heliothrope-plasma series and rock crystal; other very distinctive materials such as amethyst, moss-agate, lapis lazuli and, possibly, turquoise, although present, are definitely very rare.

### 2.3. A Sub-surface Test in MNSE Area

At the end of the 1984 campaign a small-scale specific test was monitored to investigate the sub-surface composition of the northern cluster of lithics (Fig. 4), to compare it with the more general composition of the surface complex.

For the test an area of 1 m<sup>2</sup> was selected at the western edge of the concentration. In this area the topmost surface covering, formed by loose, deeply

altered silt of a relatively dark shade, was removed down to the erosion interface with the layer(s) generating the surface spread of lithic remains. The removed deposit was then hand-sieved in dry conditions by a 1 mm. sieve, yielding very small chips as well.

This histogram in *Fig. 24* gives the absolute weight in grams of the various lithological classes once chert is left aside. The overall composition of this second assemblage may be traced back to the previously described pattern, with an absolute predominance of chalcedony over the other classes. We preliminarily assumed that the weight of the lithics, in absence of large anomalies like nodules of raw materials or heavy tools, retain a significant correlation with their number. Thus it was possible to compare the diagram in *Fig. 24* with *Fig. 7*: the higher incidence of stones such as phtanite, sedimentary and metamorphic rocks, will be observed balanced by an absolute decrease of semiprecious stones such as serpentine, jasper and the heliothrope-plasma group. Once the evaluation is limited to the semiprecious stones (i.e., after the elimination of phtanite, sedimentary and metamorphic rocks), we obtain the diagram visible in *Fig. 25*, to be compared with *Fig. 8*. In spite of a substantial increase in the chalcedony percentage, the overall pattern revealed by the sub-surface collection would appear rather consistent with that of the surface, bearing serpentine after chalcedony, followed by heliothrope-plasma and jasper (whose relative importance would appear inversely represented), rock crystal and others.

Wishing to avoid any premature inference, we may simply state that the general composition of the MNSE assemblage of semiprecious stones would appear to be substantially reflected in the composition of one of its local clusters, or, in a slightly different perspective, that the surface assemblage may be considered as the final output of a process still locally operating according to high standards of uniformity. On the other hand, divergences such as the greater incidence of phtanite in the sub-surface complex (*Fig. 24*) may suggest the presence of smaller, localized concentrations of wasters of the same stone, produced and disposed in the frame of specific operations.

The following paragraphs of the paper are concerned with the processual aspect of the assemblage, i.e. with the functional interpretation of the different classes of indicators of lapidary craft activities and their sequential arrangement.

### 3.1. Description of a Case of Multi-dimensional Variability

One of the most interesting features of the MNSE Area assemblage of semiprecious stone-working lies in its composite nature. Although the available evidence is very far from providing a systematic record of the whole set of performed cycles, we may envisage a situation in which to the "linear" variability of the indicators produced by a single cycle (e.g. a type of ornament

produced by a single stone variety) we should add the variability resulting from the cooccurrence of more cycles (e.g. various types of objects from the same stone: cfr. *Fig. 35*). The picture is further complicated by the cooccurrence of semiprecious stone types with quite different petrological features and calling, consequently, for the adoption of correspondingly wide range of manufacturing techniques. As a matter of fact, the main difficulty of the present report was to organize and describe this multi-dimensional variability in a single systematic framework.

To some extent, this goal was pursued by biasing the discussion in an analogical direction, by organizing the diagram of *Fig. 26* mainly in accordance with the structure of bead-making cycles (which in any case determine the greatest majority of the indicators) and by leaving a separate description (paragraph 3.7.) to the other sequences on record.

The diagram of *Fig. 26* is subdivided in two superimposed horizontally-oriented sections; the upper one describes the various transformational sequences affecting the recovered stone varieties, while the lower one sets out to describe the relative artefactual evidence. A major emphasis in the diagram is placed upon the horizontal direction, representing the materials' trend to be transformed into finished products. In this perspective the upper section may be conceived as the "continuity" part of the diagram, while the lower one, on the contrary, contains the corresponding elements of "discontinuity". A basic concept behind the flow diagram is that the archaeological record exerts a kind of gravitational attraction towards the manufacturing sequences, breaking their continuum by subtracting in different moments fractions of matter in different stages of transformation (e.g. debitage, unfinished products). The archaeological reconstruction of the manufacturing cycle is compelled to re-trace the reverse path, i.e. to restore ideally the transformational continuum by reconnecting the surviving evidence of the chain — the different manufacturing stages, as attested by debitage and unfinished products, plus information provided by other classes of indicators such as facilities and tools — (Tosi 1984: 25).

It has been possible to recognize a common organizational skeleton shared by the various cycles attested in the assemblage: this is expressed in the succession of stages moving from left to right in the topmost part of the diagram. Such internal units of the sequences have here been defined and conceived as generically paratactic organizational units, according to the model followed, among others, by Feinman et al. (1981). The arrangement of such units within a hierarchical structure articulated in processes, operations and phases (Buson and Vidale 1983: 33-34) would depend upon a closer analysis of each cycle as well as on specific experimental simulations. We may state, anyhow, that this basic scheme would include at least three different processes: forming (from the separation

of the lump to the rounding of the blank), drilling and polishing. The greatest majority of the indicators in MNSE Area refers to internal operations of the forming process (Fig. 27). For the drilling process the residual evidence is formed by a good number of drills and some rare bead blanks broken in perforation, while the polishing process, so far, is totally unrepresented and has been included only to complete the trajectory of the production cycle. The firing process (see paragraph 3.2.) could have intervened in several moments of the sequence, according to a more elastic schedule.

From each stage of the sequence, in Fig. 26, departs a vertical column, leading, through the definition of the various techniques on record or, sometimes, expected for the various materials, to the corresponding stages of the processed stones, entering so the lower section of the diagram, e.g. the archaeological record in its material expression. One may observe that the artefactual evidence has been arranged according the three categories of *sequence execution*, *sequence suspension* and *sequence interruption*, with increasing levels of entropy from the upper one downwards, always according to the "gravitational" concept formerly expressed. These terms do not define classes of materials or types of artefactual evidence, but indicate behavioural trends of the indicators of a given processed material in relationship with the relative manufacturing cycle. An integrate conception of the artefacts' flow within the enlarged context of a social system has been provided by Schiffer (1972).

"Sequence execution" is substantially a highly abstract category; as the successful accomplishment of all the manufacturing stages leaves relatively scanty evidence, this category is present in the archaeological record to the extent of being progressively incorporated into the finished product.

"Sequence suspension" indicates a state of temporary arrest of the manufacturing sequence, expressed by fractions of matter which, although still suitable for processing, do not enter the transformational flow, or are extracted from it by loss or selection and left aside (as in the case, for example, of stored deposits of unworked material, of unexhausted lumps or cores, or, again, of semifinished products abandoned in the archaeological record). Tosi's Semifinished Products (SFP) and Stocked Unworn Products (SUP) classes of archaeological craft indicators (1984: 25), the quoted observation of Kenoyer on re-working of chalcedony nodules at Cambay, his note on the presence of hoards of unexhausted shell cores at Moenjodaro (1984: 106), strongly suggest that, far from being fruit of accidental phenomena, the extraction of amounts of matter and, consequently, the freezing of given value amounts from critical points of the manufacturing sequences resulting in "sequence suspension", was of outstanding importance in the Moenjodaro craft production system, and in the town's economy in general. Coming back to

Cambay, the widespread heaps of nodules visible along the streets and around the houses optimally exemplify a case of sequence suspension in which the presence of unworked material performs specific economic functions (e.g., scattered storing of material to be reinserted in the flow according to market vagaries; or, again, as we would be able to observe in Cambay, the heaps may function as testing benches for training apprentices). In this perspective, then, it is possible that not only storing, but also discarding, abandonment or loss (given the elusive nature of the boundaries among such categories) of exploitable material played an important part in the Harappan organization of labour as well.

"Sequence interruption" indicates a state in which the material is characterized by features forbidding its passage onto successive stages of transformation. Flake debitage, lumps too small to be converted into beads, beads broken in perforation are example of indicators necessarily falling into this category and condemned to be definitively discarded. If fractions of matter may move from sequence execution to suspension to later re-enter the transformational flow, once they enter the interruption sphere they become static elements of the archaeological environment, unless they could be recycled in form of silica powder — for the quartz series — in other manufacturing cycles or in segments of the same cycle (for example, in the form of abrasives).

This threefold distinction has no immediate classificatory value: while the case of a bead broken in perforation is not ambiguous, it would be difficult, in general, to state if a single, small chalcedony lump should be considered as an element of sequence interruption or suspension as, to a certain extent, the possibility of turning it into a bead would depend upon hardly measurable cultural standards. The utility of this viewpoint would rest in the perspective of integrating, on a large scale, the evaluation of craft production and goods circulation and consumption in a single energy/matter flow framework. The histogram of Fig. 27 shows the relative incidence of the main classes of craft indicators by stone varieties. Flake debitage forms the absolute majority of the assemblage; if we leave aside the doubtful evidence provided by a relatively large group of small rough-outs in chalcedony and jasper (also including fragmentary specimens) it appears that the greatest majority of the indicators recovered in the site belong to the "interruption" category, conforming to the dumping dynamics hypothesized in paragraph 2.1. for the assemblage after the surface stripping experiments.

The described framework offers us the possibility of tackling with the technological evidence gathered in MNSE Area in accordance with each stone type's manufacturing cycle, as well as according to the shared organizational skeleton expressed by the vertical columns of the sequence stage. It was decided to pursue this latter course, as the description by materials

would have had the effect of overstressing the already wide variability of the assemblage.

Description of the bead-making sequences has been articulated in the following six points: Thermal Treatment of Chalcedony; Lump Separation; Rough-out Making and Regularization; Rough-out Smoothing and Blank Rounding; Drilling and Polishing.

### 3.2. Thermal Treatment of Chalcedony

A particular problem arises from the probable intervention in the manufacturing sequence of chalcedony beads of thermal treatments, with the double goal of enhancing the nodules' suitability for forming operations and, all along the sequence, of increasing the red colour of carnelian. A complex of pyrotechnological techniques, ranging from sun-heating to true firing has been described for the Cambay manufactures (Trivedi 1964: 12-14; Possehl 1981: 41-42; Francis 1982: 5). In the light of the world-wide diffusion of thermal treatment techniques of stone processing and their probable great antiquity (Purdy 1982: 40-41) the assumption that Harappan craftsmen extensively produced heat-treated carnelian seems quite reasonable (see the previous quotation from Marshall's report in paragraph 1.2.; Sankalia 1970: 38). According to the excavator, the so-called "bead factory" of Lothal was furnished with a bead-kiln to fire chalcedony (Rao 1973: 70, 77, 103; 1979: 83-84, 118-120). The sequence of firing operations affecting monochrome and banded chalcedony in Fig. 26 is intended to stress the possible recurrent application of thermal treatment in various transformational stages. At Cambay it is possible to observe, besides sun-heating of the nodules, the firing of the same nodules in closed containers arranged in open pits, the re-heating of the formed rough-outs with the identical technique, as well as additional stages of re-heating in smaller movable infrastructures (Laveri's description quoted by Purdy (1982: 41) would apply to these latter stages). At Cambay the choice of applying, after chipping, further thermal treatments in other moments of the sequence would appear rather context-dependent; the cycle's structure would retain, from this viewpoint, an inner elasticity.

The MNSE Area assemblage includes a small group of flakes classified as "pyroclastic chalcedony", accounting for no more than 1.7% of the chalcedony varieties (Fig. 16). They generally present a whitish, opaque shadow, often dotted with localized splashes of red; on the larger specimens deep inner cracks produced by heating are visible. This evidence might indicate either accidental or intentional exposure to fire. It should be stressed, on the other hand, that part of the chalcedony could actually have been turned red in this way. From other sites of the compound we have been able to recover a collection of whitish, fire-cracked chalcedony blocklets characterized by squared shapes (Fig. 28); it is not clear, however, to what extent such

forms have to be ascribed to chipping or to natural breaking following accidental firing. Artefactual evidence of chalcedony thermal treatment at Moenjodaro, in spite of its very probable application, thus remains very doubtful.

### 3.3. Lump Separation<sup>1</sup>

"Lump" in this paper indicates the minimal fraction of stone necessary that can be reduced into a bead. From a geometrical viewpoint it may be conceived as the larger solid figure in the sequence enclosing the designed bead. "Lump separation" is therefore the operation needed to isolate the lump from a larger mass. This operation, obviously, was not necessary in the case of small natural lumps such as pebbles already endowed with the required dimensions (as in the case, possibly, of some of the fragmentary pebbles reproduced in Fig. 11). Far from being an undistinguished preparatory stage, lump separation requires high standards of skill, much care, and plays a fundamental role in all the subsequent stages. Failure to control a complex set of variables such as the bead's designed dimensions, the three-dimensional orientation of features like banding, fracture lines or other imperfections, result not only in the loss of the separate fraction but also in the irreversible damage of the whole mass. This latter, in pebble or block form, was probably inspected on several occasions (starting from extraction) before lump separation. The quality of the chalcedony pebbles and texture was checked by removing one or more cortical flakes (Fig. 12); a hoard of carnelian pebbles observed on the surface of the excavated area at Chanhudaro (Sher and Vidale 1985) exhibited the same traces.

The "Lump separation" column in Fig. 26 gives the different techniques observed or expected for the various materials; for chalcedony, we find breaking, splitting and sawing. (Oriented) breaking and (oriented) sawing are expressed, again, to take into account the sawing or breaking of part of the stone mass according to planned bead shape-banding patterns; for monochrome chalcedony, on the contrary, we may suppose that attention was mainly focussed on variables such as bead size as opposed to stone texture. The term "breaking" indicates the simple separation of a suitable lump by fractioning the mass with the single constraint of the presence of at least one striking platform for the subsequent reduction. The MNSE Area assemblage contains a group of spheroid chert hammerstones as well as some flakes detached from this type of tools, perhaps used to break the stone masses.

The simplest case is exemplified in Figs. 29, A and 31, in which a pebble is broken in two halves, the fracture surface is used as platform and worked as a kind of rough core (this technique has not been identified in our site). The term "Splitting along diastatic planes" indicates a separation technique specifically monitored for the exploitation of chalcedony defect such as the

strongly fibrous structure and the coarse crystalline banding evident in a large part of the recovered specimens. Fibrous structure determines the existence of fracture lines and, potentially, planes, radially orientated towards the geoid's inner cavity. Banding, on the other hand, when marked by significant discontinuities in its micro-crystalline texture, forms as many diastatic surfaces orthogonally orientated to the former radial lines. This three-dimensional pattern was exploited to break and split the stone directly into squared blocklets, with the result that lump separation actually coincided with rough-out making and, partially, regularization, ruling out most of the chipping phases, with the consequent noticeable hastening of the cycle. The subdivision pattern of fibrous chalcedony is represented, in a highly ideal and simplified scheme, in *Fig. 29*. Such a pattern is here directly produced by a regular, concentric structure of the geoid. G. M. Bulgarelli (personal communication) rightly called my attention to the strong variability affecting chalcedony nodular structure, particularly when stones have been sorted out from alluvial contexts. Nonetheless, the proposed hypothetical reconstruction, after a close examination of a relatively large set of indicators, account for some regularities recognizable across the forming process. *Fig. 29, B* shows the separation pattern resulting from a series of vertical blows applied along the radial fracture lines. *Fig. 29, C* and *D* are series of cortical flakes whose removal allows the isolation of the squared geoid's core, in turn subdivided into the squared elements *E* and *F*. *F*, again, whose median section is formed by the coarse elongated quartz crystals filling the central cavity, may be horizontally split in two symmetrical halves along the central diastatic plane. Elements *E* and *F* (as will be discussed for rough-out smoothing operations) are designed to enclose two different types of beads (*Fig. 30*). Examination of elements of type *C* and *D* reveals that larger and thicker flakes (confront *Fig. 29, D* with *Fig. 32, G, H*) could have been worked as other lumps (*Fig. 32, B, C, D, J, K; Fig. 37, A, E*). As stated above, this reconstruction does not claim to be valid for every form of chalcedony nodule, nor to be predictive for every type of indicator, but to simply account for some recurrent schemes in lump separation.

*Fig. 32, A* is a small geoid with traces of chipping, perhaps aimed to turn it directly into a rough-out. *Fig. 32, B, C, E* are elements corresponding to types *C* of the proposed reconstruction; *D, F, J, K* appear to be lateral flakes deeply penetrating the geoid's core, while *G* and *H* would correspond more closely to type *D*. *Fig. 32, I*, finally, is an element of type *F* with the exception of the chipped nodule *A* and of some chipping traces visible on *D* and *J*, all these remains have simply been discarded after separation.

The other possible way of obtaining directly squared lumps is sawing. Mackay's statement on the employment of metal saws in stone-working has already been

mentioned. Presence and use of bronze-copper saws in Harappan workshops has recently been discussed by Kenoyer (1984: 103) with reference to shell-working. Comparisons with the Minoan world (among others Younger 1981: 31; Bartlett Wells 1974) suggest that such high technological standards were fully available to Late Chalcolithic techno-cultural complexes. In the "Lump separation" column the term "sawing" is followed by a question mark. In the MNSE Area, in fact, we recovered only two stone items with sawmarks: a tablet-shaped alabaster residue and a parallelepiped-like element in a hard, fine-grained metamorphic rock of a greenish colour (*Fig. 33*). Their recovery, although sufficient to demonstrate the employment of bronze-copper saws in the MNSE Area, does not prove their employment in bead-making. In the assemblage there is no evidence of chalcedony sawing. Some rare sawn fragments of this latter material have been found on the surface of other sites of the compound or appear in the Museum Reserve Collection (*Fig. 34*). They document chalcedony sawing for the detachment of thin, translucent plates or stick-like elements which do not immediately fit in the range of bead-making indicators we presently know. Sawing, therefore, has been inserted in lump separation techniques mainly after the evidence provided by the workshops of Chanhudaro, where it was extensively applied to comply with the strict constraints exerted by the forming stages of the long-barrel cylinder beads. The employment of metal saws would have the effect of producing stone rods with continuous, regular striking platforms relegating chipping to a very controlled phase of minute flaking.

Among the other semiprecious stones, serpentine is the only one presenting a lump separation pattern partially similar to that reconstructed for fibrous chalcedony. In *Fig. 35, A* and *B* two squared lumps are reproduced which have been apparently detached with strong blows following large inner diastatic planes. This technique, unlike that for chalcedony, was restricted to the separation of large, rather irregular blocklets for which a further stage of reduction was probably necessary. For jasper, as well as for the rarer rock crystal (whose structure appears generally more compact and homogeneous), we hypothesized simpler breaking operations. The same hypothesis is advanced for the last group, comprehending various types of metamorphic fine-grained rocks. Evidence of sawing in this context has already been discussed.

### 3.4. Rough-out Making and Regularization

In reading the proposed definition of "Lump" one may have observed that it did not depend on a set of clearly defined physical attributes, but rather on a more general evaluation of the element's structural relationship with the sequence chain. Similarly, the proposed definition of "Rough-out" — the element resulting from a phase of physical reduction of the lump accomplished

by series of discontinuous movements — emphasizes the systemic nature of many bead-making indicators, becoming meaningful only when inserted in their transformational trajectory. The definition places "Rough-out" immediately after "Lump" underlining that the lump's transformation in rough-out is carried out with discontinuous movements (chipping and minute flaking) in opposition to the almost continuous movements characterizing the transformation of rough-outs into blanks. The distinction between "chipping" and "minute flaking" is very arbitrary: it has been formalized to express the ideal existence of two subsequent stages of lump reduction, the first one defined by the appearance of the basic form, the second by a careful finishing aimed at levelling the irregularities present on the rough-out surfaces, in spite of the fact that this latter stage is not clearly recognizable in the assemblage under examination. The importance of regularization would lie in the fact that the more the rough-out surfaces are close to level planes, the easier and surer the following grinding stages will be. Part of the recovered rough-outs appear to have been detached with simple breaking and splitting techniques (Fig. 36 A-D), and subsequently chipped to remove the cortical parts (Fig. 36, A, C, D). More effective chipping seems to have been practised in other cases (Figs. 37-39). Defective or broken chalcedony rough-outs represent, after flakes, the most common indicator in the assemblage (Fig. 27). This suggests that chipping phases were characterized by high loss rates, probably due to the presence of the same diastatic planes which were exploited to facilitate the process.

Examination of the rough-outs recovered in MNSE Area as well as in other sites of Moenjodaro reveals that generally they had quadrangular sections (Figs. 36; 37 B, C; 38 A-D; 39 A-C). In other activity areas we recovered some rarer rough-outs with triangular section. A single find in the MNSE Area shows that larger, elongated beads sometimes required hexagonal sections (Fig. 40, e; but note Fig. 40, C, in which the same section is pursued directly by grinding). We have no artefactual evidence of the tool-kits employed in this delicate forming stage. Requisite of chipping stages are the possibility to use a wieldy, light percussion apparatus with tools having minimal contact surfaces with the rough-outs, thereby facilitating the maximum visibility for reduction operations. We might conceive it as an apparatus not very different from the one utilized today at Cambay, where "... a worker chips the stone into a crude shape (a roughout) by bracing it against the tip of an iron stake driven into the ground or a mud floor. He strikes with a flick of his wrist a water buffalo horn hammer mounted on a thin bamboo stick" (Francis 1982: 5).

### 3.5. Rough-out Smoothing, Blank Rounding

The "Blank" is the element produced by a further phase of reduction from a rough-out accomplished by almost continuous movements. Rough-outs result from chipping, a series of discontinuous movements with tools operating mainly in a "positive" sense (i.e. the tool is operated on the processed material — but the particular case of the indirect-reverse percussion method adopted at Cambay should be remembered); blanks are produced by grinding, a series of almost continuous movements in which tools are used in a "negative" sense (the processed material is operated against the grinding tool). The diagram in Fig. 26 takes into account for bead blanks two different transformational stages, respectively defined "Primary Blank" and "Rounded Blank".

Whatever the section, rough-outs undergo continuous grinding of the surfaces, so as to be turned into as many smoothed planes. A "Primary Blank" is then a smoothed element with polygonal section more apt to enclose the rounded form of the bead. As most of the recovered rough-outs have quadrangular sections, the relative primary blanks are more or less regular parallelepiped-like elements simply obtained by rubbing the surfaces onto the parallel grinding planes of the tool (Figs. 35, C, D; 40, F). A "Rounded Blank" is obtained with more subsequent phases of grinding the blank's edges and corners, till the element reaches the designed circular or elliptoid sections (Fig. 40, A-C). This transformation is accomplished with progressive faceting phases, as shown by many of the and/or broken beads (Figs. 35, G; 41, B; 52, A, C, H, K; see also Gwinnet and Gorelik 1981: figs. 4, 14, 16). It will be observed that part of the beads entered drilling process before a complete rounding took place, as documented by Gwinnet and Gorelik for the industries of the Iranian sites of Shahr-i Sokhta and Hissar (1981: 21). Probably this latter task was conceived as pertaining to the polishing process.

Grinding traces on rough-outs are rather frequent; they document several unsuccessful attempts to turn them into blanks, thereby probably marking another critical point of the manufacturing sequence. An examination of them allows a closer look at certain aspects of the smoothing operations. Serpentine elements, being relatively soft, retain very clear rubbing traces. Fig. 35, C is a rough-out which, being most probably already defective after chipping, has been discarded after undergoing further damage in grinding. The four major faces have more or less extended ground surfaces; the rubbing direction follows the main axis of the piece (cf. Gwinnet and Gorelik 1981: 19). In this case, the element was to have assumed a convex profile already in the form of primary blank. A second fragmentary specimen of the same stone (Fig. 35, D), broken apparently in analogous circumstances and retaining the same profile, suggests that such shapes were

recurrent in this transformational stage. *Figs. 35, G and I*, document facetting stages, respectively, for beads and gamesmen. *Fig. 35, H* is a small primary blank with slightly convex faces, bearing traces of an incomplete horizontal groove at 1/3rd of its height. *Fig. 40, A-C* show three interesting examples of broken and split chalcedony rough-outs which have directly been worked as primary blanks, grinding the edges (*Fig. 40, A, C*) and the corners (*Fig. 40, B*). In the three cases, anyhow, it is clear that the operation planed the whole face of the element, wearing away the cortex remains (*Fig. 40, A, B, D*) as well as the surfaces formed by the coarse-crystalline diastatic planes exploited for lump separation (*Fig. 40, C*). Cortex remains are still visible on the specimen in *Fig. 40, D*, which was almost completely smoothed when the blank broke down along an inner white vein. *Fig. 40, F* shows a heliotrope primary blank smoothed, like in the case of *Fig. 35, C* all over the 4 main faces, and severely damaged in rubbing. Another chalcedony blank, this time already rounded, and broken in rubbing along an inner vein is shown in *Fig. 41, A*.

One of the most interesting aspects of this operation is represented by the exploitation of carnelian-agate banding pattern (*Figs. 30, 42*). Grinding, in this case, was not only monitored to smooth-off geometrical or structural irregularities of the rough-out, but was critically accomplished according to specific aesthetic models, exposing surfaces with regularly arranged, attractive chromatic contrasts. *Fig. 42, B* demonstrates how elements of type *E* and *F* (cf. *Fig. 30*), separated by breaking the geoid in specific points, might be designed for the production of two different types of beads: a first type having the axis orthogonally oriented to the bands' direction, which, due to their position in the *E* section of the nodule, retain beautiful concentric bandings, and the so called "eye-stone" beads, with the central axis running parallel to the bands' orientation; in this latter variety the superimposition pattern of bandings is carefully followed by a gentle rubbing with a cameo-like technique, exposing sometimes a single band for all a blank's face. Such beads seem to have been intensively produced in the site's working unit, but this evidence could also be due to the recurrent problem of the blanks' particular fragility.

*Fig. 42, A, B* are two fragmentary carnelian-agate rough-outs manufactured according to the described model. *Fig. 42, C-H* are all fragmentary rough-outs broken in grinding; it appears evident how carefully the artisan isolated the red band in the center of the blank, in the concentric framing of the other lighter zones (see also *Figs. 43-44*). *Fig. 42, I* is a small flake of moss-agate worked with a similar concept. The remaining pieces of *Fig. 42* document in rough-out form (*J*) and as fragmentary blanks (*K, L*) even more complex solutions in which the main bead axis is orientated according the banding direction, while the

minor axis had been diagonally inclined, allowing other decorative patterns.

The "bead-stones" identified by Mackay at Chanhu-daro have already been mentioned. The tools utilized at Moenjodaro for the same purpose have been identified in some re-utilized grinding stones bearing clear evidence of highly polished surfaces interrupted by series of radial or parallel grooves (*Figs. 46-48*). According to the proposed reconstruction, continuous smooth surfaces in the bead-working tools were determined by transformation of rough-outs into primary blanks, through continuous grinding of parallelly orientated planes; the grooves, on the other hand, would have been formed by the subsequent rounding of the same blanks by smoothing-off edges and corners, as well as by prolonged rubbing of small blanks with rounded central section.

The first specimen *Figs. 46, left; 47*) is a red quartzite piece resulting from the re-utilization, after breaking, of one of the more common grinding stones so common in the Moenjodaro houses; it was collected from the old excavations dumps north-east of the HR Area. It is roughly circular in shape, and bears five grooves of no more than 2 mm. in depth. The opposite face presents the coarse surface these tools normally have in their primary utilization. The second bead-rubbing tool (*Figs. 46, right; 48*), again in red quartzite, has been recovered in the DK-B, -C dumps. Apparently this fragment belonged to a larger elongated grinding stone, re-utilized before breaking. It has three grooves orientated with the main axis of the tool. In this case, they are deep and regular enough to suggest that series of beads were contemporary smoothed in them by pressing with a wooden tablet; the described technique was commonly adopted at Cambay before the introduction of continuously revolving mechanical wheels. In this specimen the functional surfaces relative to bead-rubbing have been almost completely destroyed by later punching and hammering phases in which the piece was used as an anvil, receiving a dense pattern of sub-circular depressions all over its faces. These dynamics of continuous re-utilization with changing functions are particularly evident in the third tool, recovered, this time, on the surface of MNSE Area (a similar case of prolonged utilization of heavy polished stone tools with progressive modifications, contrasting with the simpler use and discard of flaked stone tools, is described in a different cultural context in White and Modjeska 1978). The tool (*Figs. 49-51*) is a heavy block of fine-grained sandstone with a grayish colour, originally belonging to a large and thick grinding stone which, as shown by the rough surface of its inferior face was originally designed to be embedded into a clay bench or floor. After breakage, part of the tool was adapted to other functions; visible along the breaking surfaces (*Fig. 51*) are the traces left by the detachment of few large flakes to regularize the tool's shape. The stone presents

an irregular ogival contour, with a major flattened, slightly concave functional face; the distal extremity and one of the side faces are noticeably convex and highly polished, while the remaining lateral face bears characteristics rather similar to those of the main face. Here the stone has a shallow circular depression, probably left by beating and revolving a spheroid pounder or hammerstone. Its central position could suggest that it was left after the tool's breakage. The central depression is partially disguised by a series of traces which, on the main face, appear to have been produced by an intense phase of punching/hammering, in the form of small, elongated depressions whose size suggest a rather limited contact surface between the stone and the beating body. The traces are more frequent on the lower section of the main face. They have an average orientation of  $22^\circ$  ca. with the main axis of the stone. The described features indicate that a squatting worker used the tool as an anvil, keeping the basal fracture surface immediately in front, with the stone lying horizontally. A similar pattern of traces is visible on the flattened side face reproduced in Fig. 50, demonstrating that the tool was easily moved to exploit its various functional surfaces. This latter side, as well as the main face, appear to have later been employed in bead-making. Close examination of the surface revealed the presence of some irregular, shallow groovings analogous to those identified in the former specimens. The grooves' shallowness may indicate that the tool's employment with this function was not a very prolonged or intensive one. As a matter of fact, all pre-existing traces were subsequently erased by a general polishing of all the stone's faces, particularly effective on the rounded extremity and on the convex side face; this polishing is very uniform, and could be the result of long abrasive operations on continuous surfaces such as the ones, for example, provided by leather. Finally, the rounded tip of the stone was strongly damaged by a series of five-six strong blows testifying the tool's occasional return to an anvil-like function.

### 3.6. Drilling and Polishing

A handful of beads broken in perforation was recovered from the site's surface. Some of the specimens (Figs. 35, G; 43; 52, A, B, F; 53) are beads split in two parts in the first stages of drilling by excessive pressure; in other cases (Fig. 52, G, J) only a very detailed examination of millimetric splinters revealed the presence of sectors of the perforation hole. In the case attested by Fig. 52, J we may imagine a kind of explosion of the drilled blank. Fig. 52, A, C, D, as already stated in paragraph 3.5., show how some beads underwent drilling before the forming process was completed. Fig. 52, E is a primary blank in jasper which, after perforation had been suspended on one extremity (Fig. 54), and badly performed at the opposite one, was finally discarded.

If we consider the artefactual evidence of the drilling tool-kits, we find a disproportionate amount of data on the drills' points as opposed to the paucity on the sophisticated system presumably employed in the process, whose ingenious organization may be imagined (Salvatori and Vidale 1982) but the employment of micro-drills on blade for the perforation of long beads of the harder stones of the silica series has not yet been proved. According to Mackay (1937: 5) the coincidence of chert micro-drills on blade and phtanite ones at Chanhudaro could be explained by articulating the drilling process into two distinct operations: scratching the drill-guide depressions and actual drilling. Although the technological analysis of the large collection of chert drill-heads will yield new substantial evidence, possibly revealing a multi-functional pattern of utilization, we will preliminarily follow Mackay's suggestion, hypothesizing that at least a part of the drill-heads were used in tracing the starting scars for subsequent drilling (Gwinnet and Gorelik 1981: fig. 12). We cannot rule out, on the other hand, that such drill-heads were also operated onto beads of softer materials like, for example, limestone or serpentine.

The ratio of sub-cylindrical phtanite drill-heads versus chert specimens can be approximately evaluated to 1:25, defining the former type as a very rare one in the MNSE Area. This type of tool is well known since Mackay investigations at Chanhudaro; it has subsequently been described at Shahr-i Sokhta (Piperno 1973; Tosi 1973: Figs. 2, 5; Piperno 1976: Figs. 2-4; Piperno 1981; Gwinnet and Gorelik 1981: 23), Mehrgarh (Jarrige 1981: 109) Mundigak (Jarrige and Tosi 1981: 135), and Shahdad (Salvatori and Vidale 1982: 8-9, Fig. 3). As attested for the chert specimens, phtanite drill-heads were manufactured, apparently, in the same context of the bead-making cycles. The greatest part of the recovered phtanite is represented by waste flakes (Fig. 56); less common are lumps (Fig. 57, left), rough-outs (Figs. 57, right; 58) and finished and utilized drill-heads (Figs. 60-63). The tools were manufactured out of rod-shaped, square-sectioned rough-outs, probably detached in turn from squared lumps (Fig. 57), although the separation technique is not clearly recognizable. The rough-outs generally present a continuous, abrupt re-touch along the four main faces. An examination of the recovered flakes revealed the presence of the thin, scale-like elements detached in forming the rods (Fig. 59). One of the recovered specimens, anyhow, presents continuous unretouched surface more difficult to interpret (Fig. 57, extreme right). Like the analogous rough-outs from Shahr-i Sokhta (Piperno 1973: 120) the Moenjodaro drill-heads show a narrowing contour in correspondence with the designed working end. The analysis of the collection of utilized drill-heads allowed us to draw some relevant conclusions. In confuting Mackay's assertion that Chanhudaro drills were formed by "... grinding them in much the same way as the beads" (1937: 6) Piperno (1973: 120-123) tries to account for

Mackay's mistake. As a matter of fact, as the Chanhudaro specimens are identical to those from Moenjodaro (Sher and Vidale 1985) we may now argue that such an interpretation was drawn from the fact that, unlike the Shahr-i Sokhta specimens, Harappan drill-heads were carefully smoothed on the hafting section, as described by Mackay in the following sentence: "...the butt... more often than not has slightly faceted sides, to prevent its turning in the handle or chuck in which it was fixed" (1937: 6). The point is illustrated in Fig. 60 A-E, H-J. All these phtanite drill-heads from the MNSE Area have a hafting part sectionally square (A, C, E, H, I, J) or polygonal (B, D) contrasting with the roughly chipped surfaces of Shahr-i Sokhta drills (Piperno 1973: figs. 9.1, 9.2). The reasons of this choice on behalf of the Harappan lapidaries probably lie more in the need to maximize control on the points' centering than in preventing it from turning inside the handle, as the rough hafting part of the drills from Sistan doubtlessly granted a better resistance.

Very few specimens were recovered in a state of completion. The remaining collection is formed by broken cylindrical points (Figs. 60, F, G; 61; 63), specimens fragmentary of the upper hafting section (Figs. 60, B, C, H; 63) and broken hafting sections (Figs. 60, D, E, I, J; 64, 65). The analysis of this latter group leads to the identification of a probable new type of indicator. A certain number of fragments of the hafting section was characterized by rounded convex extremities, with clear traces of rotatory friction (Figs. 60, I, J; 64, 65), whose shape and size contrasted with the features commonly encountered in the tips of the working ends. In some cases (Fig. 60, I, J) the elements had both the extremities rounded, showing that the drill-head fragments had been re-utilized twice. Another outstanding feature of the rotatory wear traces was that their inner rotational axis was not always orientated with the central axis of the drill piece (Fig. 60, I). The probable explanation of the function of these elements would be in an ethnographical comparison with the Nagara drills (Fig. 66). The drill is provided with an upper small pivot in copper protruding from the wooden handle extremity and centered with the drill-head. The pivot rotates against a coconut shell cap used by the worker to press the revolving tool against the bead blank, thereby assuming a rounded convex tip (Fig. 66, C). The data from the MNSE Area, therefore, could indicate that broken drill-heads were re-utilized as upper pivots.

In the list of the finds from the old excavations there are more possible candidates for the identification of the drill-caps which presumably were characterized by a wide typology. Kenoyer (1984) has recently published a thick piece of *Lambis* shell bearing a series of shallow circular depressions analogous to those visible on the interior of the coconut shell in Fig. 66, B, clearly indicating its function. A possible drilling stone-cap of great interest because it was recovered with other possible stone-working indicators (see foot-

note 1) was classified by Mackay (1938: 412) as a "pedestal"<sup>6</sup>. The piece is marked DK 12390; together with the almost identical piece DK MM 653 (Figs. 67, 68) it is now conserved in the Moenjodaro Museum collection. Both the pieces are odd hemispherical objects in compact limestone, bearing a major cylindrical hole in the center of the top and a second similar hole departing from the border. The surface is covered with an uninterrupted network of small circular depressions ranging in diameter from 1.6-1.8 to 4.7-6.0 mm. The depressions could well represent the traces left by an upper drill-pivot. The pattern of distribution of such traces is characterized by localized clusters of depressions with the same diameter, indicating the frequent consecutive repetition of the same operation; within the same cluster, the inner axis of the holes is very variable, showing possible changing orientations of the worker's wrist, and recalling the divergence in orientation observed between the pivot's axis and the rotatory wear trace in some of the specimens. In both the pieces, the uneven surface created by the depressions was later smoothed off, possibly with the purpose of creating a new starting platform for the pivot.

To conclude the discussion on the artefactual evidence of drilling, an observation on the much debated question of the central depression on the tip of the working-ends of the phtanite drills (Mackay 1937: 6-7; Piperno 1973: 124-126; Gwinnet and Gorelik 1981: 23). This feature is present in all the points we recovered, with the exception of the one reproduced in figs. 60, H and 63, in which the opposite feature of a small nipple is clearly visible. The structural character of this opposition recalls the results of some experiments of Gorelik and Gwinnet (1978: Fig. 12, D, B), supporting Piperno's interpretation of the tip feature as a by-product of the interaction between the variables and constraints internal to the physical systems of drilling. On the other side, as this variability of the tip form is probably a direct function of the relationships between the petrological characteristics of the tool and the processed stone, it further underlines the composite nature of the MNSE Area stone-working industry.

We have no evidence of the polishing process, whose traces are hardly discernable even by SEM inspection (Gwinnet and Gorelik 1981: 23). It is commonly hypothesized that this process was accomplished by tumbling the beads in leather bags with abrasive mixtures (Mackay 1937: 9; Tosi and Piperno 1973: 20), according to procedures similar to those described by Trivedi (1964: 16).

### 3.7. Other Technological Aspects

Separate mention is deserved by the scanty evidence we have on lapis lazuli bead-making, represented by a couple of flakes and a single small rough-out lost or discarded after perforation (Fig. 52, I). Comparing

the position of this rough-out with the reconstruction available for the other materials (Fig. 26) we may observe the anomalous behaviour of the lapis lazuli sequence. The rough-out is a squared blocklet probably designed for a disc-bead, separated by splitting, which had to be perforated before any polishing took place, thereby conforming to the reconstructed trajectories of lapis lazuli bead-making at Shahr-i Sokhta (Tosi and Piperno 1973: 19) and Hissar (Bulgarelli 1974: 26) and more recently recognized at Shahdad (Salvatori and Vidale 1982: 8).

We have already mentioned the possible presence, together with bead-making, of manufacturing cycles relative to other classes of objects, as in the case of the serpentine gamesmen of Fig. 35, I.

A second type of object produced in the MNSE Area was the cube-shaped chert micro-weight in banded chert; the surface collection allowed the recovery of an unexploited lump and two broken chipped rough-outs (Fig. 71), as well as a certain amount of flakes of the same distinctive material. The cubes were chipped into shape, smoothed as primary blanks and polished. Close inspection of the micro-debitage recovered by sieving showed the presence of series of small chips with smoothed and/or polished surfaces. If pieces like Fig. 72, A-F could be part of bead blanks, a faceted fragment like Fig. 72, G would confirm the impression of the contemporaneous occurrence of different types of products.

Fig. 73 collects a part of the bronze-copper fragments so far recovered. All the pieces are very small and non-diagnostic, due also to their bad state of oxidation. A great part of the fragments are small particles of sheets such as Fig. 73, A. Possible rod-like elements suggesting small chisels like Fig. 73, B, C, D, H (note that D and H could bear a kind of functional end) are rarer. Other fragments could belong to pins, nails or wires (Fig. 73, F, G, I) and provide no more clear evidence. It should be stressed that a point like Fig. 73, G could also, theoretically, be a drill-head, but its strong oxidation, together with the pieces inner fragility, would render any inspection very difficult.

### Concluding Remarks

The paper has tried to outline the technological component of the MNSE Area semiprecious stone industry, as it appears from the surface record, within the wider context of the town's lapidary craft production. Although the proposed reconstructions are still largely fragmentary and sometimes simply conjectural, the analysis underlined the composite character of the semiprecious stone-working assemblage, pointing to a relatively high degree of complexity in the space/time organization of labour by the Harappan production unit(s) under examination. This degree of complexity would become even more meaningful if we take into account the components of the artefactual record

which have been ruled out from the present study (in first place a significant group of specialized retouched and/or worn chert tools not immediately related to bead-making) as well as if we consider how frequently in the interpretation of some classes of indicators we could hypothesize the intervention of quite different production cycles. If the secondary context of the surface distribution will be confirmed by the current researches, we are going to face a basic question: how is the outlined technological complexity reflected in a disposal context? Such a question could also be enlarged to a more general one: to what extent the secondary depositions common at Moenjodaro may spread light onto the organization of labour in craft production? In the next future, a significant part of our efforts at Moenjodaro will be monitored to provide a first set of answers.

### Footnotes

1. Considering the published list of finds, Block 6A, DK-G South may be taken as a good example of a possible "workshop" reconstructed by this type of approach (see Mackay 1938: 75-77). One observes that, out of the 10 unfinished beads listed in our Tab. 1, two had been found in the same building (Mackay 1938: 502). The list of the other antiquities recovered in this context goes as following:

TYPE OF OBJECT	PLATE	ROOM	DEPTH
Ivory Awl	CV, 13	42	-10.7
Pottery Bulla	CXL, 34	35	-10.4
Copper Pan	LXXII, 10	39	-10.3
Limestone Pedestal	CIV, 23	42	-9.2
Copper Dish	CXXII, 6	40	-8.9
Whetstone	CVI, 21	41	-8.8
Pottery Kohl-jar	LVI, 4	43	-8.8
Ivory Fish	CXXXVIII, 52	34	-8.6
Bronze Saw	CXIX, 10	33	-8.3
Copper(?) Axe Frag.	CXX, 31	33	-8.3
Faience Pin-Head	CXXV, 32	39	-8.1
Copper Arrow-Head	CXXV, 46	33	-7.8
Cover-Brick	LIV, 15	42	-6.0
Mace-Head(?)	CIV, 5	41	-5.5
Painted Jar	LVI, 36	40	-5.6
Agate Die	CXL, 63	41	-5.6

(note that the two unfinished beads previously mentioned were not included by Mackay in the present list).

Now, if we think that, as discussed in paragraph 3.6., the limestone pedestal could be interpreted as a kind of stone drilling cap, and that the list could include a hone found in the street between Blocks 6A and 25, not far from a door of the building (Mackay 1938: 406), as well as a chisel (*ibidem*: 457), not reported in the list but apparently found in room 33, and, finally, that the Mace-Head is unfinished, the resulting picture would recall another lapidary's workshop (in spite of the altimetric dispersion of part of the indicators).

2. In the present paper, as in many other reports, the two terms "heliotrope" and "bloodstone" are equivalent.

- 3 Both grave PG/958 at Ur and G.77 at Shahr-i Sokhta contained some tools and wasters in more common materials such as a broken palette in white limestone, limestone flakes, some pebbles at Ur (Woolley 1934: 207) and a sandstone grinder together with a cortical flake from a pebble at Shahr-i Sokhta (Piperno 1976: 10).
- 4 In drawing the lithic indicators reproduced in Figs. 32, 36-42, 52 I had to face the very particular problem of combining graphically the different spheres of information relative to the chipping technique, the presence of inner features of the stone such as the presence of cortex or coarse diastatic planes, as well as to express, for the agate elements, the structure of chromatic contrasts which, sometimes, turned out to determine the orientation of the bead. I have tried to overcome this difficulty by drawing the volumetric chipping features according to the usual standards of lithics' graphic reproduction, limiting the interpretation to the critical features; cortex portions are characterized with irregularly dotted areas, while the parallel diastatic planes exploited in the forming phases are expressed with uniform dotted surfaces (for example, Fig. 38, A; Fig. 40, A, C). For what concerns chromatic contrast in agate banding I have decided, like in the case of the chipping features, of marking only the attributes which could be deemed culturally significant. Given the author's scarce experience in the field of lithics' reproduction, the results are open to every criticism.
- 5 "No. 23 (DK 12390) (see also Pl. CXXV, 34). 1 in. high by 2.56 ins. in diameter at the base. Grey, cherty limestone. At first glance this hemispherical object looks like a piece of natural coral, for, except its smooth, slightly convex base, it is covered all over with a number of shallow pittings which vary in diameter from 0.19 in. to a very small size. These pittings are irregularly placed and a trefoil occurs here and there. In the middle of the top of this stand there is a shallow depression, 0.12 in. deep and 0.45 in. in diameter in whose floor is a hole, 0.2 in. in diameter by 0.5 in. deep. A second hole cut horizontally in the side of the stand is 0.16 in. in diameter by 0.65 in. deep." (Mackay 1938: 412).

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Fig. 1

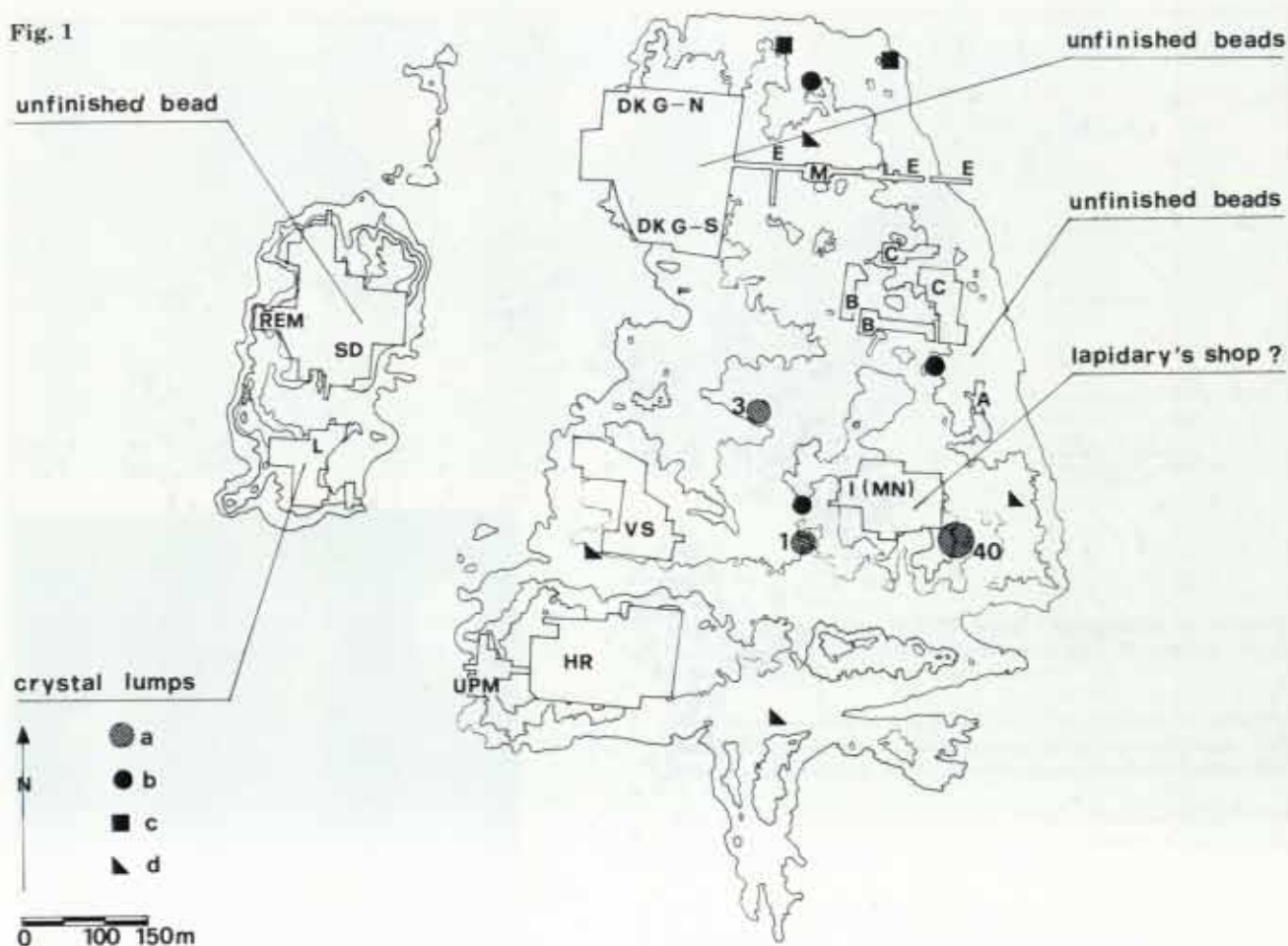


Fig. 1 Moenjodaro. Distribution of semiprecious stone-working indicators according to the early excavation reports and the preliminary data from the surface survey: a. Major Craft Activity Areas involved in semiprecious stone-working; b. Minor concentrations with bead blanks; c. Isolated chalcedony blocks or lumps; d. Minor concentrations of flakes.

Fig. 2 Moenjodaro. Chalcedony rough-outs in the Moenjodaro Museum Reserve Collection.

Fig. 3 Moenjodaro. Bead blanks in jasper, chalcedony and other semiprecious stones in the Moenjodaro Museum Reserve Collection.

Fig. 2



Fig. 3



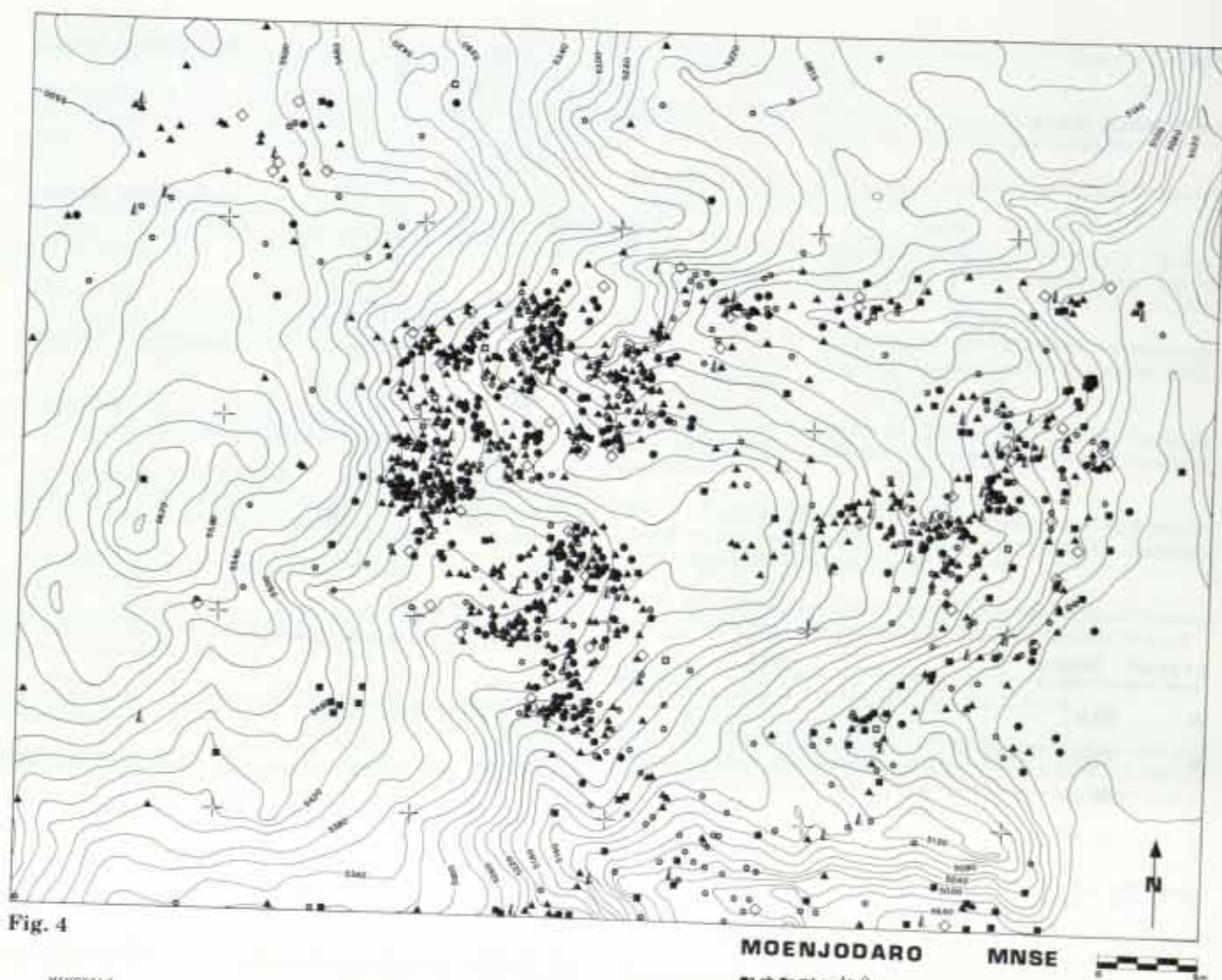


Fig. 4

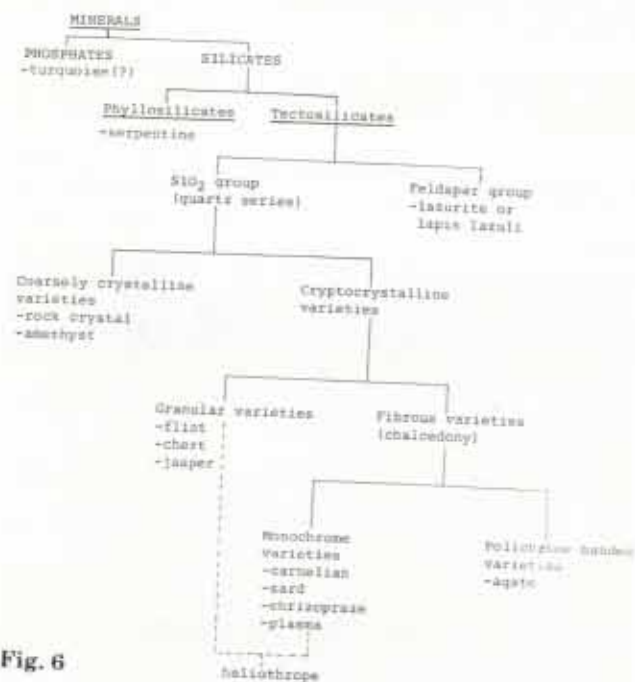


Fig. 6

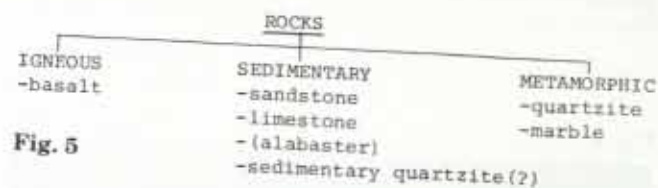


Fig. 5

Fig. 4 Moenjodaro, MNSE Area. Distribution map of selected classes of semiprecious stone-working indicators: a. Quartzite flakes; b. Chert blades; c. Chert and phthanite drill-heads; d. Unfinished chert drill-heads; e. Chalcedony debitage; f. Jasper debitage; g. Serpentine debitage.

Figs. 5, 6 Classification of the identified materials according to Dana's system (Hurlbut 1959).

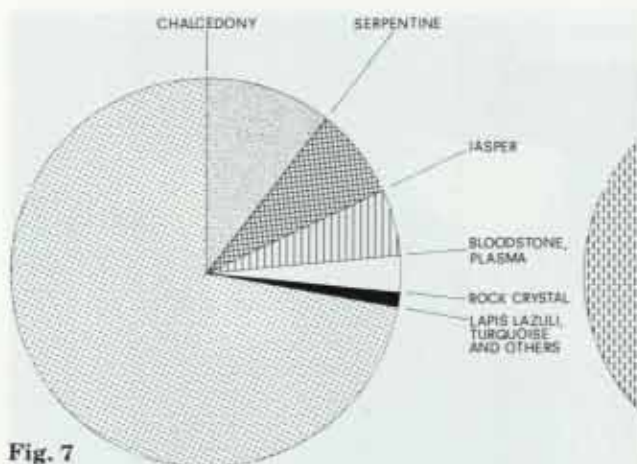


Fig. 7

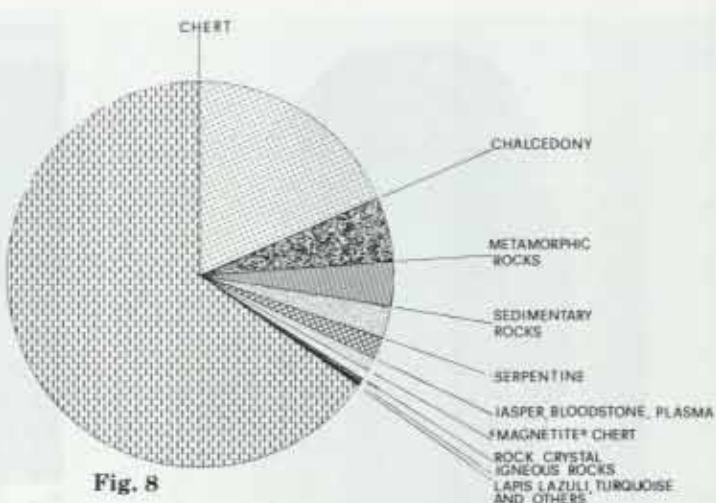


Fig. 8



Fig. 9

Fig. 10



Fig. 7 Moenjodaro, MNSE Area. Composition in relative percentages of the total lithic assemblage. "Magnetite" chert is Mackay's definition for phtanite.

Fig. 8 Moenjodaro, MNSE Area. Composition in relative percentages of the semiprecious stone assemblage (but sedimentary, metamorphic, igneous rocks, chert and phtanite).

Fig. 9 Moenjodaro, MNSE Area. Group of artefacts collected from a 1x1 m. unit, showing the high incidence of chert tools and wasters.

Fig. 10 Moenjodaro, MNSE Area. Fragment of a quartzite grinding stone. Flakes detached by tools of this type are a very common find on the surface of the site (see also Fig. 4).

Fig. 11 Moenjodaro, MNSE Area. Small chalcidony lumps in the form of broken alluvial pebbles.

Fig. 11



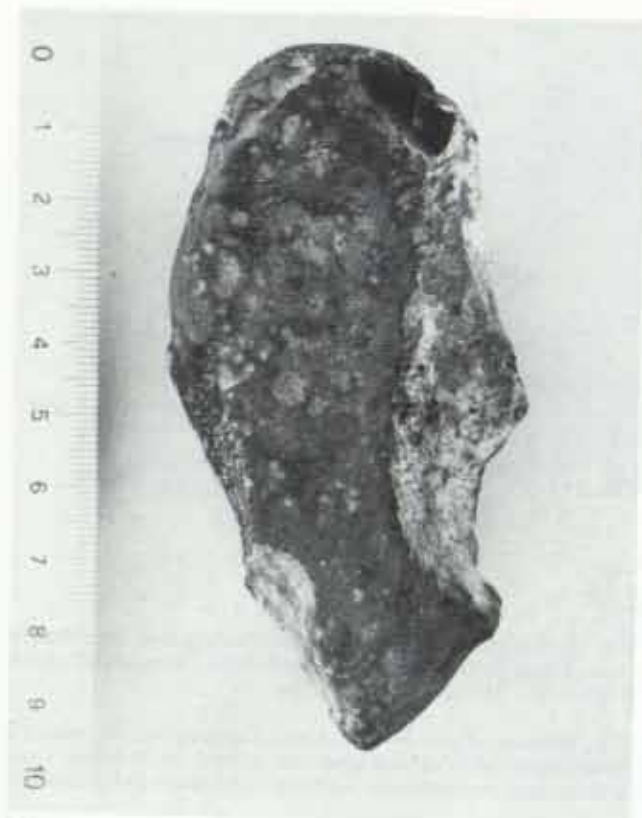


Fig. 12

Fig. 15



Fig. 13



Fig. 14



Fig. 12 Moenjodaro, MNSE Area. Chalcidony alluvial pebble with chipping traces.

Fig. 13 Moenjodaro. Large chalcidony fibrous blocks from the Moenjodaro Museum Reserve Collection.

Fig. 14 Moenjodaro. Large chalcidony fibrous block from the Moenjodaro Museum Reserve Collection.

Fig. 15 Moenjodaro, MNSE Area. Cortical flakes from chalcidony pebbles from the surface collection.

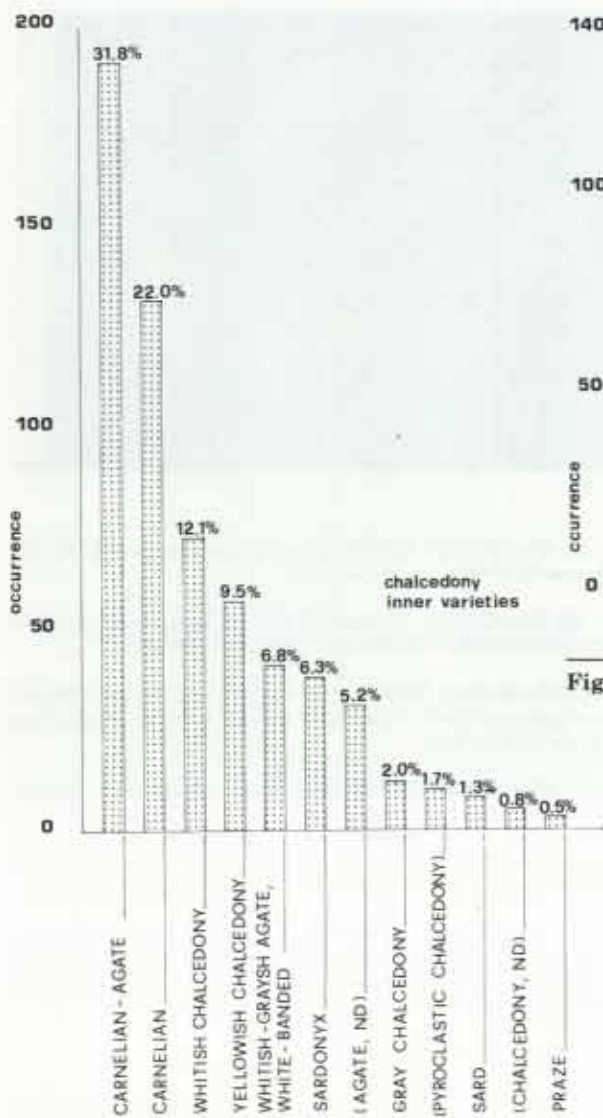


Fig. 16

Fig. 19

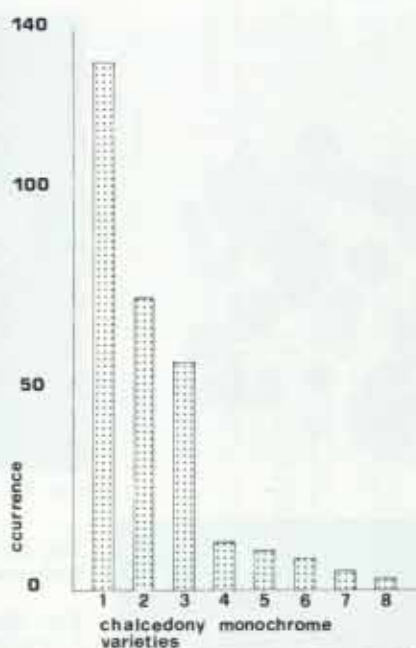


Fig. 17

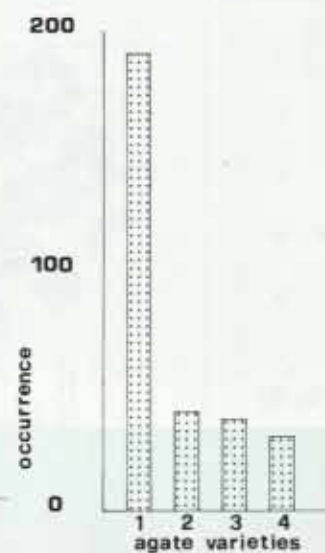


Fig. 18

Fig. 16 Moenjodaro, MNSE Area. Relative incidence of chalcedony internal variety in the assemblage from the surface collection.

Fig. 17 Moenjodaro, MNSE Area. Incidence of chalcedony monochrome variety in the assemblage from the surface collection. 1. Carnelian; 2. Whitish chalcedony; 3. Yellowish chalcedony; 4. Grayish chalcedony; 5. Pyroclastic chalcedony; 6. Sard; 7. Not determined; 8. Praze.

Fig. 18 Moenjodaro, MNSE Area. Incidence of agate varieties in the assemblage from the surface collection: 1. Carnelian-agate; 2. Whitish-grayish agate; white-banded; 3. Sardonyx; 4. Not determined.

Fig. 19 Moenjodaro, MNSE Area. Serpentine debitage from the surface collection.

Fig. 20 Moenjodaro. Jasper lumps from various localizations of the site (surface collection 1982-83).

Fig. 20





Fig. 21



Fig. 22



Fig. 23

Fig. 21 Moenjodaro, MNSE Area. Jasper debitage from the surface collection.

Fig. 22 Moenjodaro. Lumps of rock crystal from various localizations of the site (surface collection 1982-83).

Fig. 23 Moenjodaro, MNSE Area. Rock crystal flakes (left) and quartz splinters from chalcedony geoids' core recovered from the surface collection.

Fig. 24 Moenjodaro, MNSE Area. Composition of the assemblage recovered by sub-surface stripping (see paragraph 2.3.): C. Chalcedony; P. Phtanite; LM. Limestone; Q. Quartzite; S. Serpentine; B. Bloodstone (heliotrope), plasma, etc.; J. Jasper; I. Igneous rocks; R. Rock crystal; L. Lapis lazuli and others.

Fig. 25 Moenjodaro, MNSE Area. Composition in relative percentages of the semiprecious stones assemblage recovered by sub-surface stripping (but sedimentary, metamorphic, igneous rocks, chert and phtanite: cf. Fig. 24).

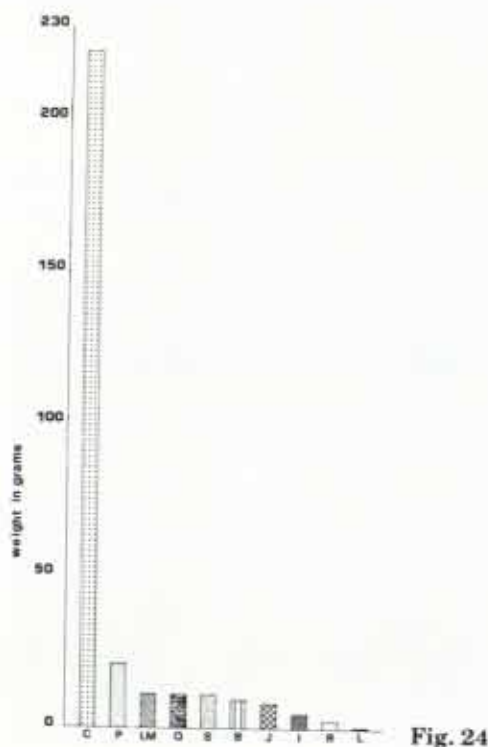


Fig. 24

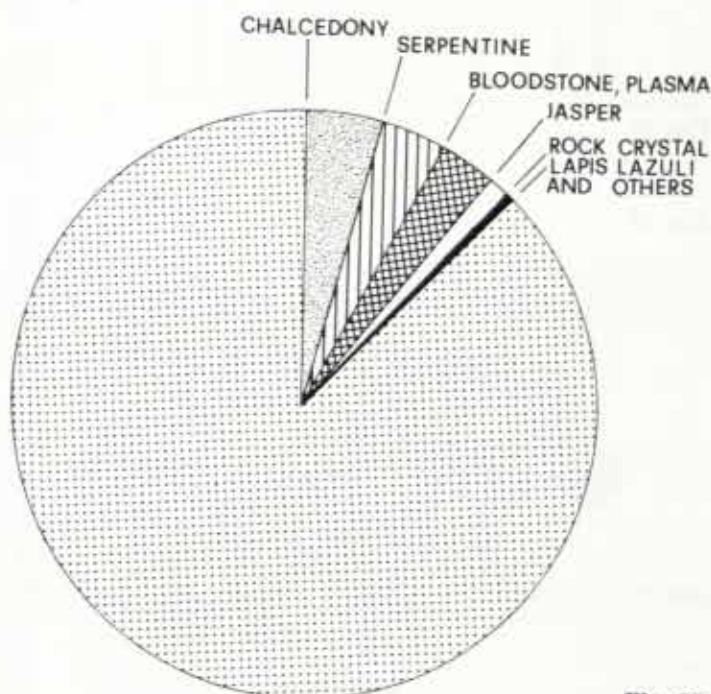
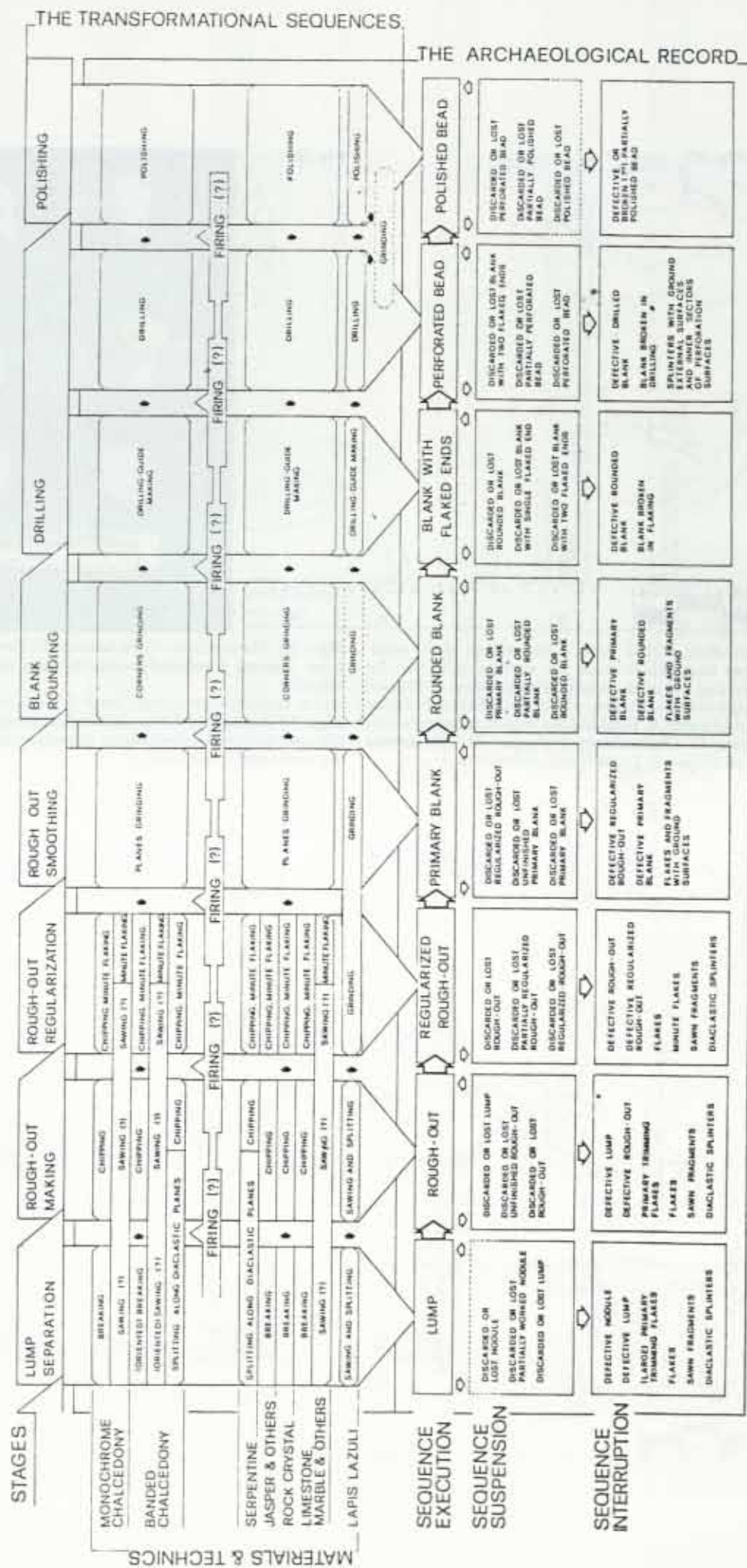
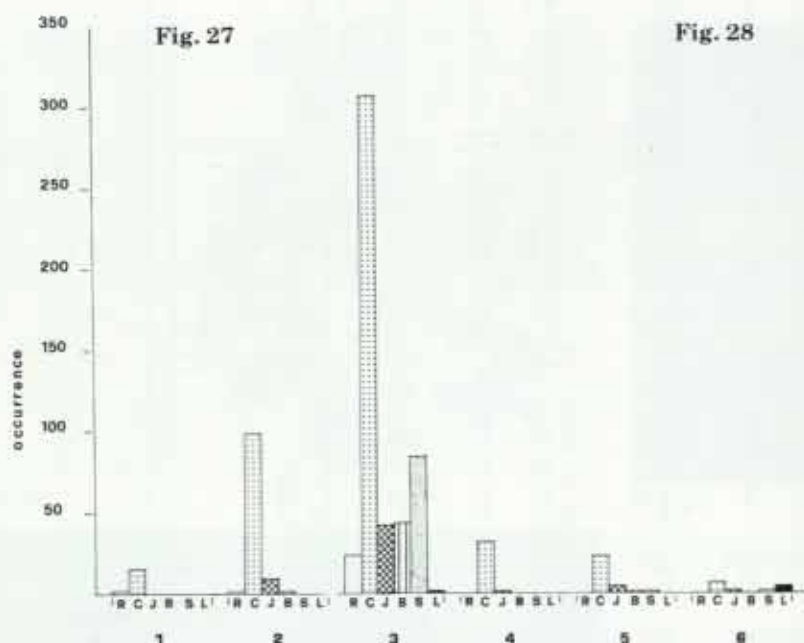


Fig. 25

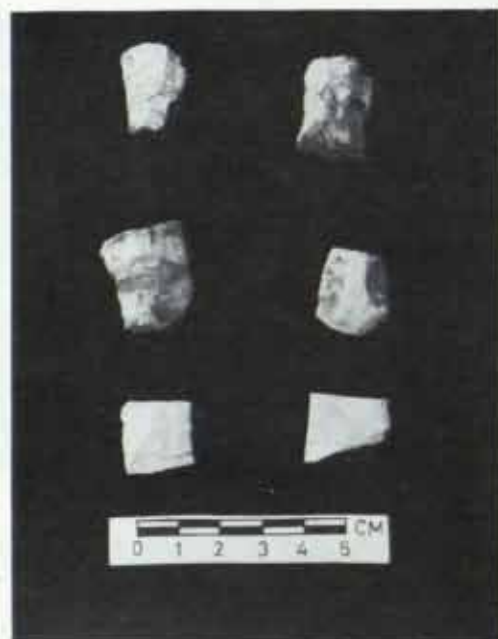
**Fig. 26** Flow diagram representing the transformational sequences recorded in the MNSE Area and the relative artefactual evidence (for explanation see text).





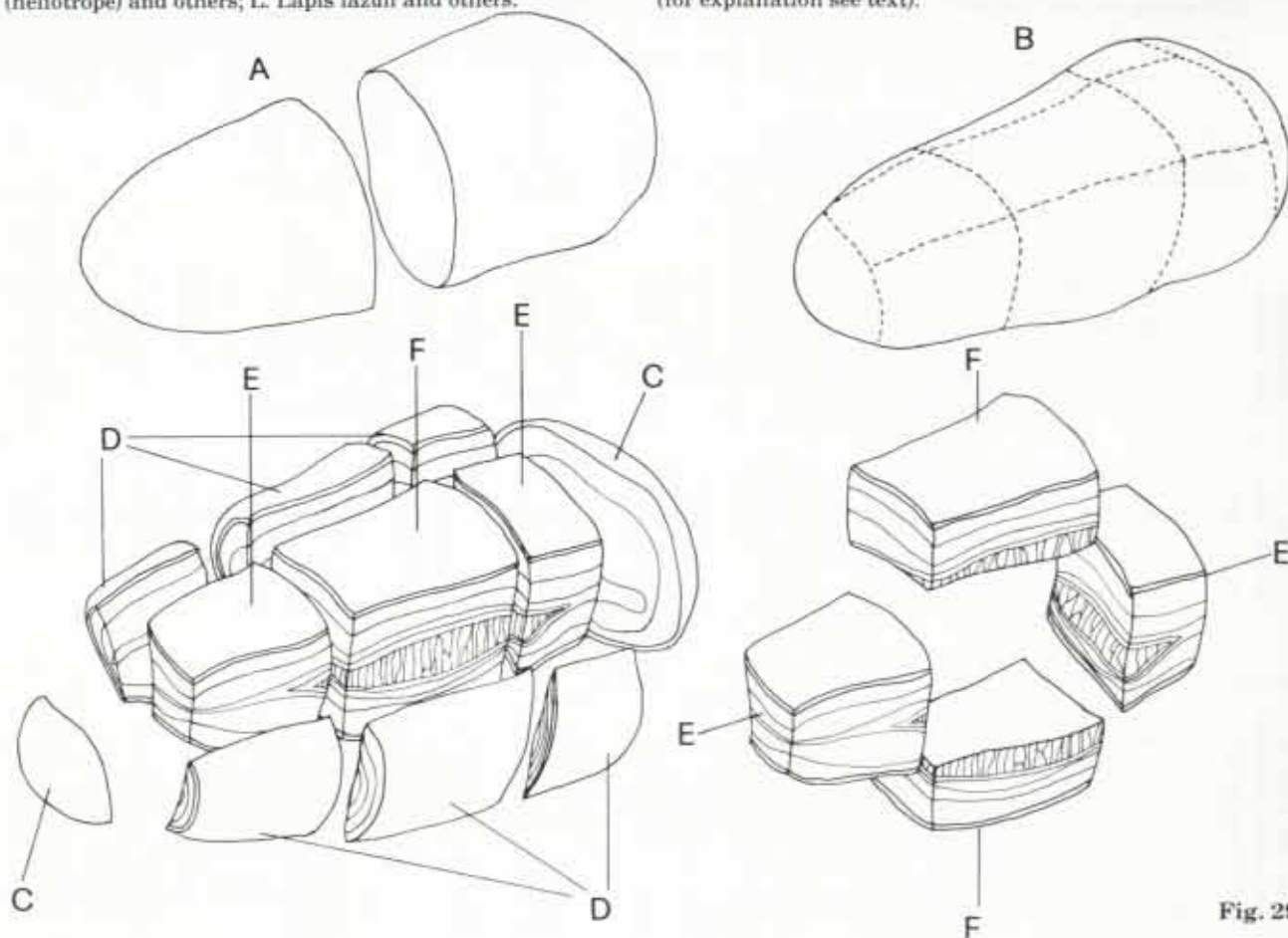
**Fig. 27** Moenjodaro, MNSE Area. Composition of the semi-precious stones assemblage from the surface collection by stone varieties and selected classes of indicators: 1. Blocks, lumps; 2. Rough-outs; 3. Flakes; 4. Cortical flakes; 5. Inner flakes from geoid's core; 6. Bead blanks broken in perforation. R. Rock crystal; C. Chalcedony; J. Jasper; B. Bloodstone (heliotrope) and others; L. Lapis lazuli and others.

**Fig. 28**



**Fig. 28** Moenjodaro. Pyroclastic blocklets of chalcedony from various localizations of the site (surface collection 1982-83).

**Fig. 29** Pattern of lump separation reconstructed for the fibrous varieties of chalcedony recovered on the MNSE Area (for explanation see text).



**Fig. 29**

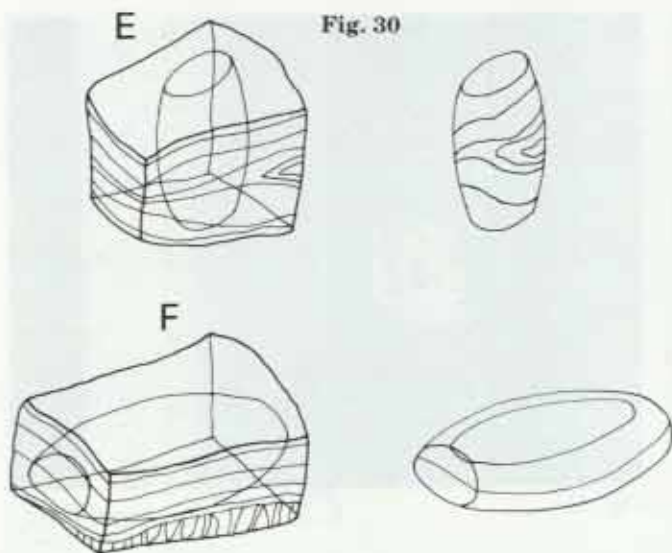


Fig. 30

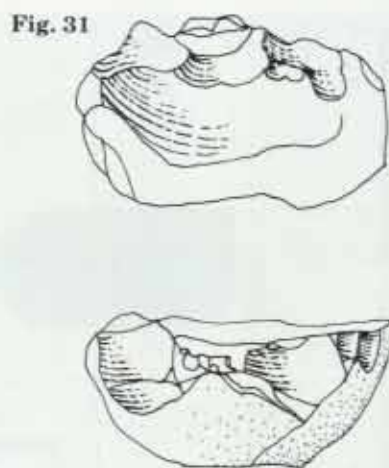


Fig. 31

Fig. 30 Types of orientation of beads according to the model described in the previous figure (for explanation see text).

Fig. 31 Moenjodaro. Fragment of chalcedony nodule with chipping traces recovered from the DK-G north dumps.

Fig. 32 Moenjodaro, MNSE Area. Chalcedony debitage in the form of chipped or broken alluvial pebbles.

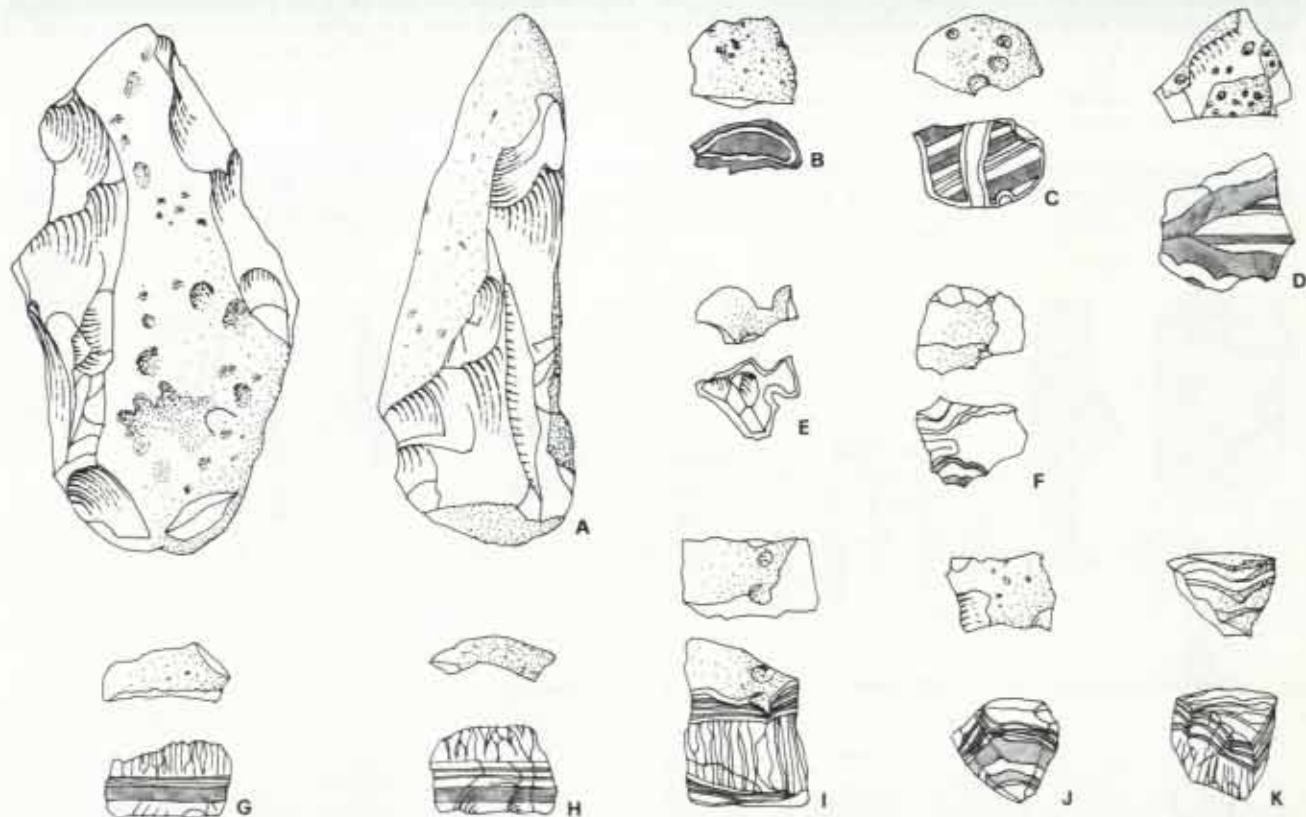


Fig. 32

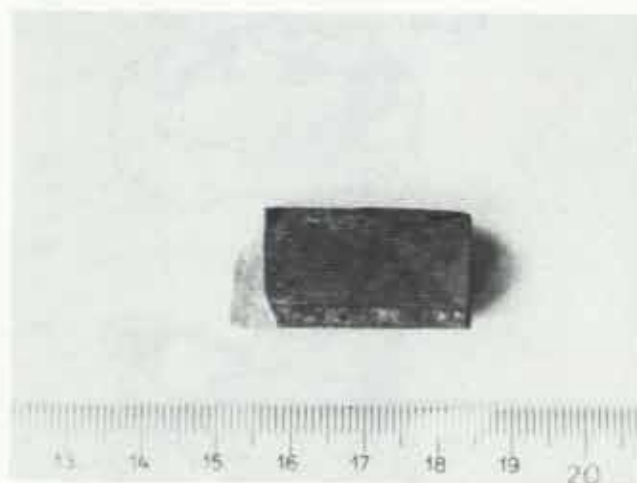


Fig. 33

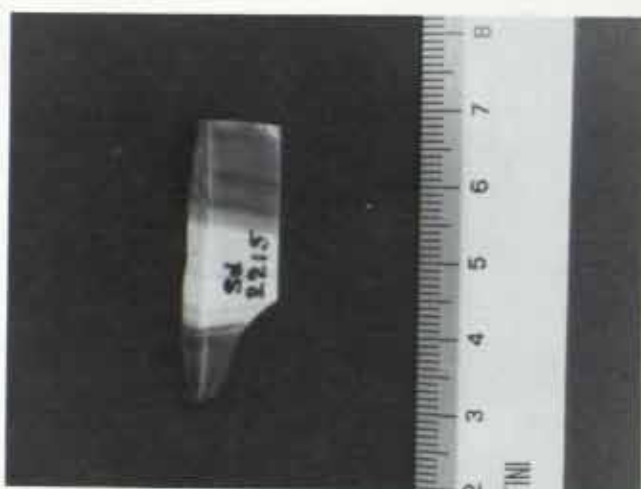


Fig. 34

Fig. 33 Moenjodaro, MNSE Area. Sawn blocklet in a greenish metamorphic stone from the surface collection.

Fig. 34 Moenjodaro. Chalcedony sawn element from SD Area, from the Moenjodaro Museum Reserve Collection.

Fig. 35 Moenjodaro. Lumps, rough-outs and blanks in serpentine. A, D, G, H, I from MNSE Area; the other items were recovered from different localizations of the site in the frame-work of the 1982-83 campaign of surface analysis.

Fig. 36 Moenjodaro, MNSE Area. Fibrous chalcedony rough-outs separated with a splitting technique (see the model of Figs. 30, 31) recovered from the surface.

Fig. 37 Moenjodaro, MNSE Area. Chalcedony rough-outs recovered from the surface.

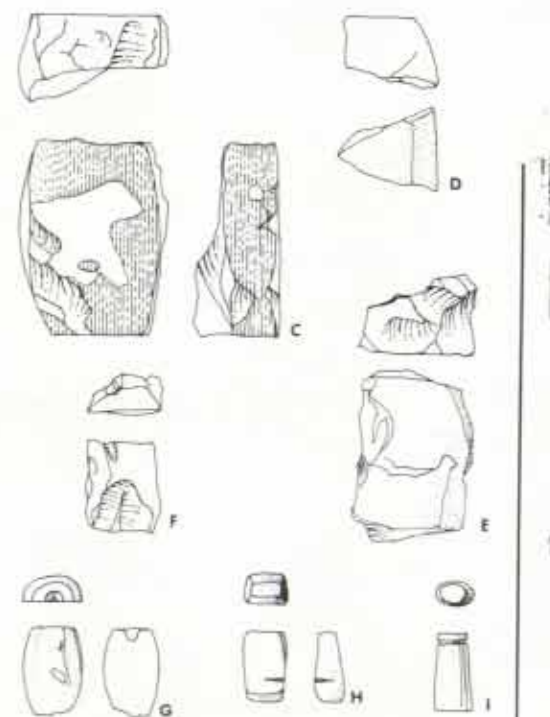
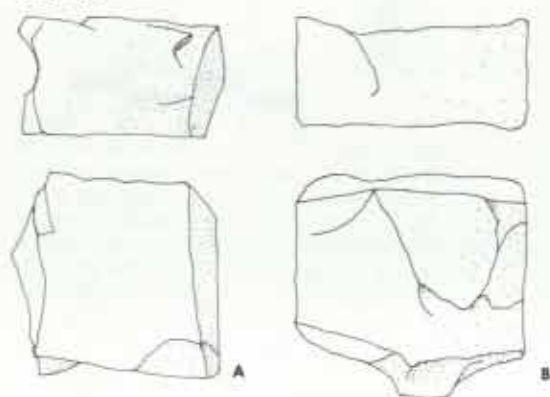


Fig. 35

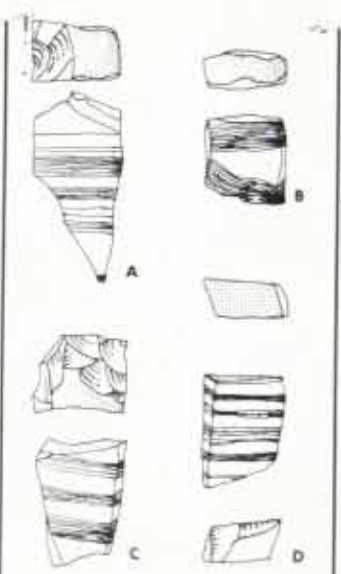


Fig. 36



Fig. 37

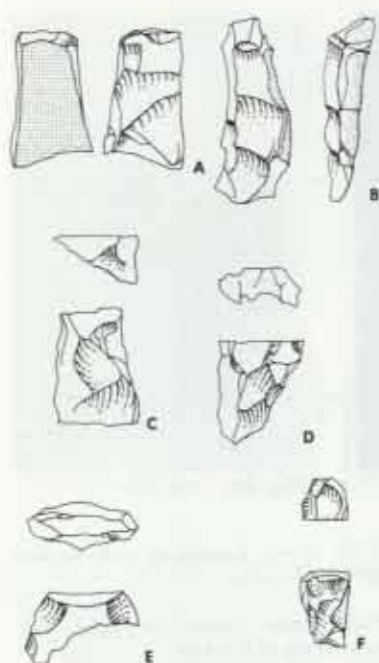


Fig. 38

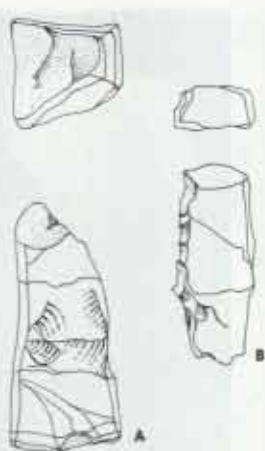


Fig. 39



Fig. 41

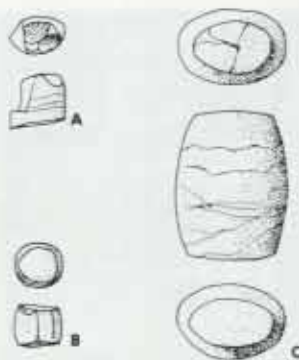


Fig. 41

Fig. 38 Moenjodaro, MNSE Area. Chalcedony (A-E) and rock crystal rough-outs (F) recovered from the surface.

Fig. 39 Moenjodaro, MNSE Area. Jasper and jasper-like rough-outs recovered from the surface.

Fig. 40 Moenjodaro, MNSE Area. Chalcedony (A-E) and heliotrope (or bloodstone) rough-outs with partial polishing traces recovered from the surface.

Fig. 41 Moenjodaro, MNSE Area. Chalcedony (A), Turquoise(?) (B) and heliotrope (C) bead-blanks from the surface of the site.

Fig. 42 Moenjodaro, MNSE Area. Carnelian-agate (A-H, J-L) and moss-agate (I) rough-outs and bead-blanks from the surface of the site.



Fig. 42

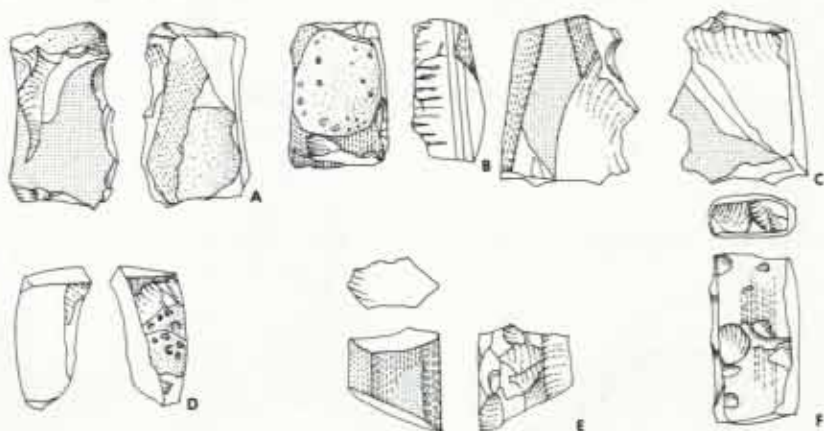


Fig. 40

Fig. 40



Fig. 43



Fig. 44



Fig. 45



Fig. 46

Fig. 43 Moenjodaro, MNSE Area. Complete and broken bead-blanks from the surface of the site.

Fig. 44 Moenjodaro, MNSE Area. Carnelian-agate "eye-stone" bead-blank from the surface of the site.

Fig. 45 Moenjodaro, MNSE Area. Turquoise(?) bead-blank from the surface of the site.

Fig. 46 Moenjodaro. Bead-smoothing quartzite tools from the HR Area and DK-B, -C Area dumps (surface collection 1982-83).

Fig. 47 Moenjodaro. Bead-smoothing quartzite tool from the HR Area dumps (surface collection 1982-83).

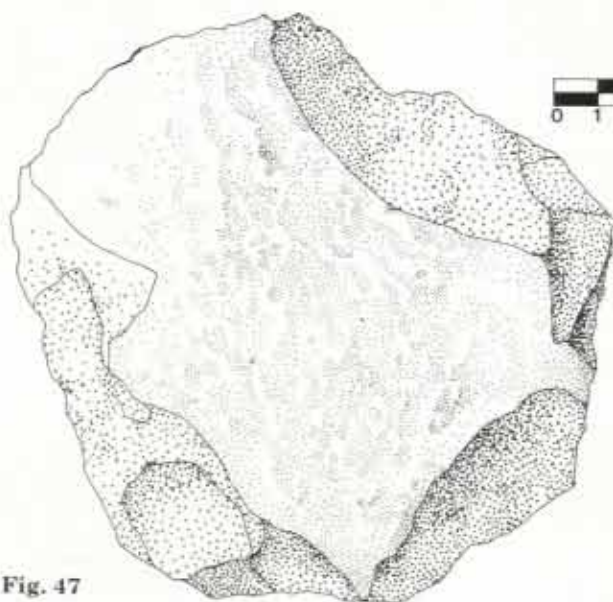
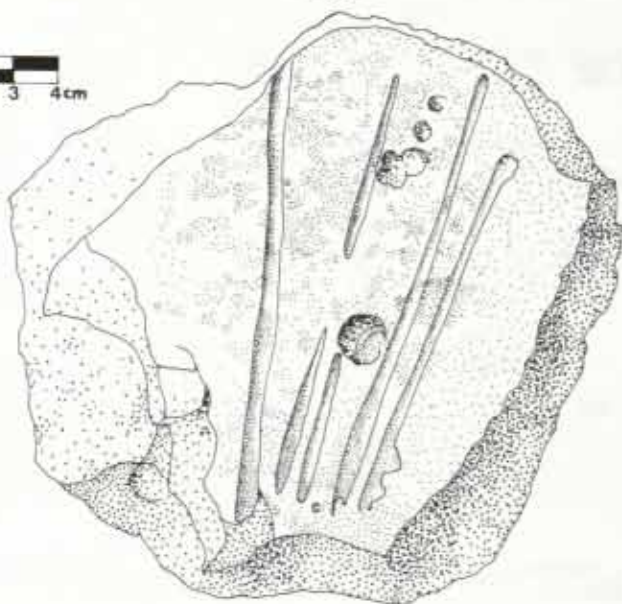


Fig. 47



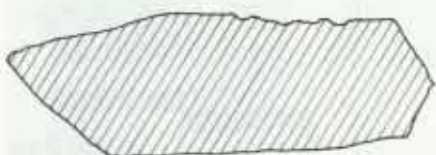
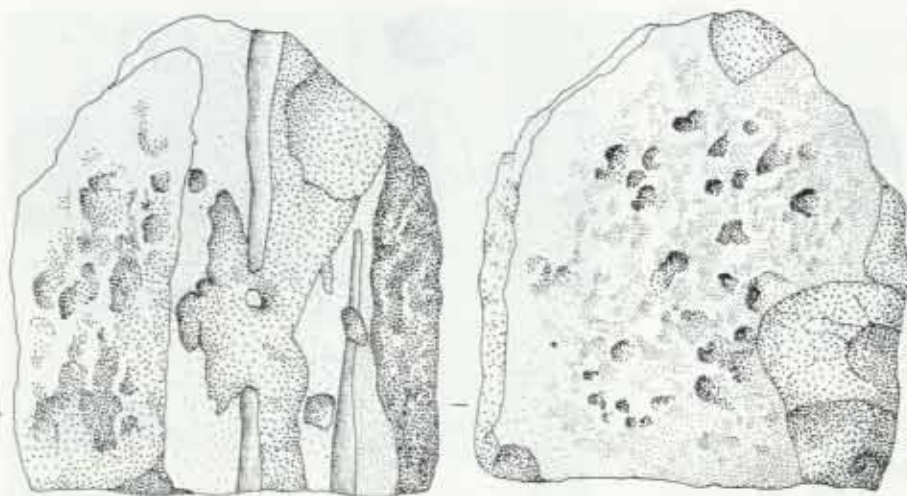


Fig. 48

Fig. 48 Moenjodaro. Bead-smoothing quartzite tool from the DK-B, -C Area dumps (surface collection 1982-83).

Figs. 49, 50, 51 Moenjodaro, MNSE Area. Sandstone tool with bead-smoothing traces recovered from the surface of the site.



Fig. 49



Fig. 50

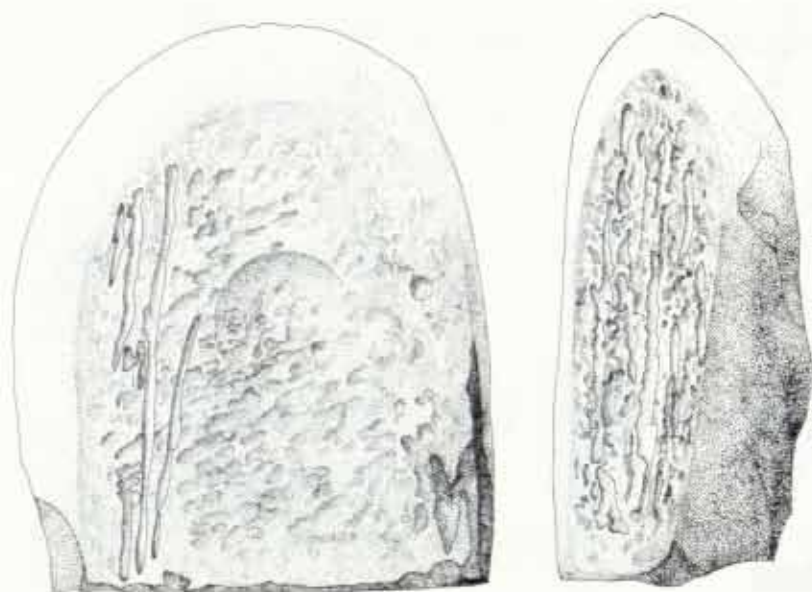


Fig. 51



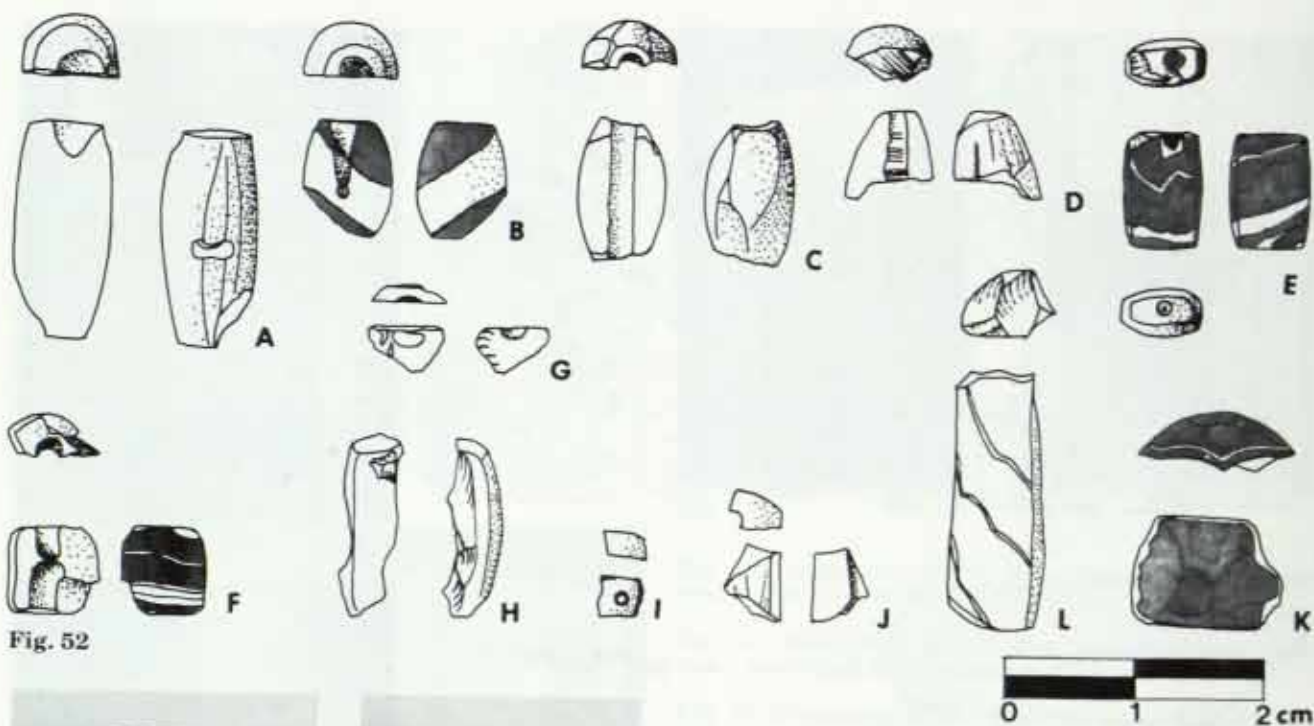


Fig. 52



Fig. 53



Fig. 54

Fig. 52 Moenjodaro, MNSE Area. Limestone (A, C, L), jasper (B, E), chalcedony (F, G, H, J, K) and lapis lazuli (I) bead-blanks broken in perforation from the surface collection.

Fig. 53 Moenjodaro, MNSE Area. Chalcedony bead-blank broken in perforation from the surface of the site.

Fig. 54 Moenjodaro, MNSE Area. Jasper bead-blank damaged and discarded during perforation from the surface of the site.

Fig. 55 Moenjodaro, MNSE Area. Chert drill-heads from the surface collection.

Fig. 56 Moenjodaro, MNSE Area. Phtanite debitage from the surface collection.

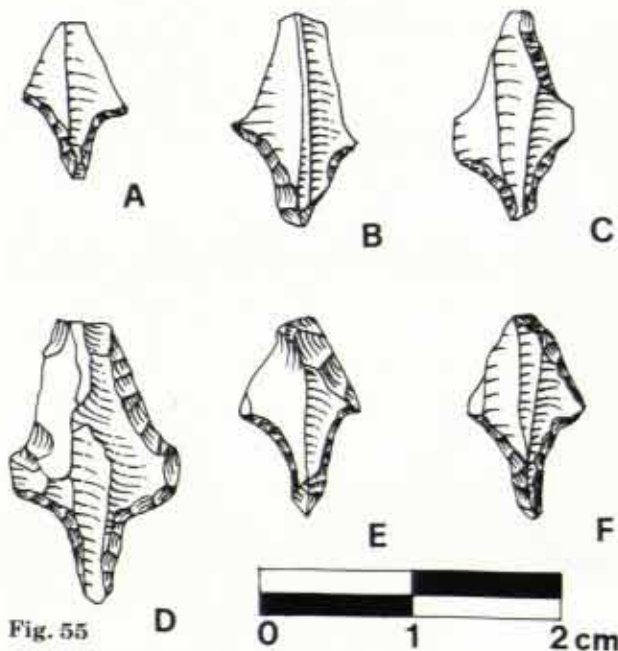


Fig. 55

Fig. 56





Fig. 57



Fig. 58



Fig. 59

Fig. 61



Fig. 62



Fig. 63

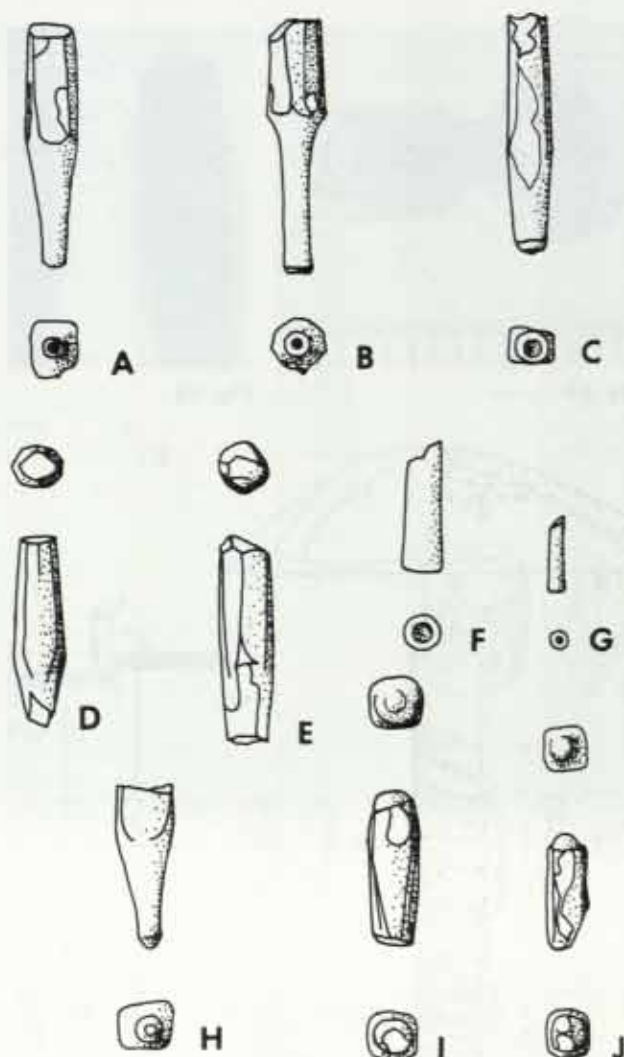


Fig. 60

Fig. 57 Moenjodaro, MNSE Area. Phtanite lump and chipped rough-outs from the surface collection.

Fig. 58 Moenjodaro, MNSE Area. Phtanite chipped rough-out from the surface collection.

Fig. 59 Moenjodaro, MNSE Area. Phtanite scale-like flakes detached in rough-out manufacture from the surface collection.

Fig. 60 Moenjodaro, MNSE Area. Phtanite drill-heads from the surface of the site.

Figs. 61-63 Moenjodaro, MNSE Area. Distal extremities of phtanite drill-heads from the surface of the site.



Fig. 64



Fig. 65

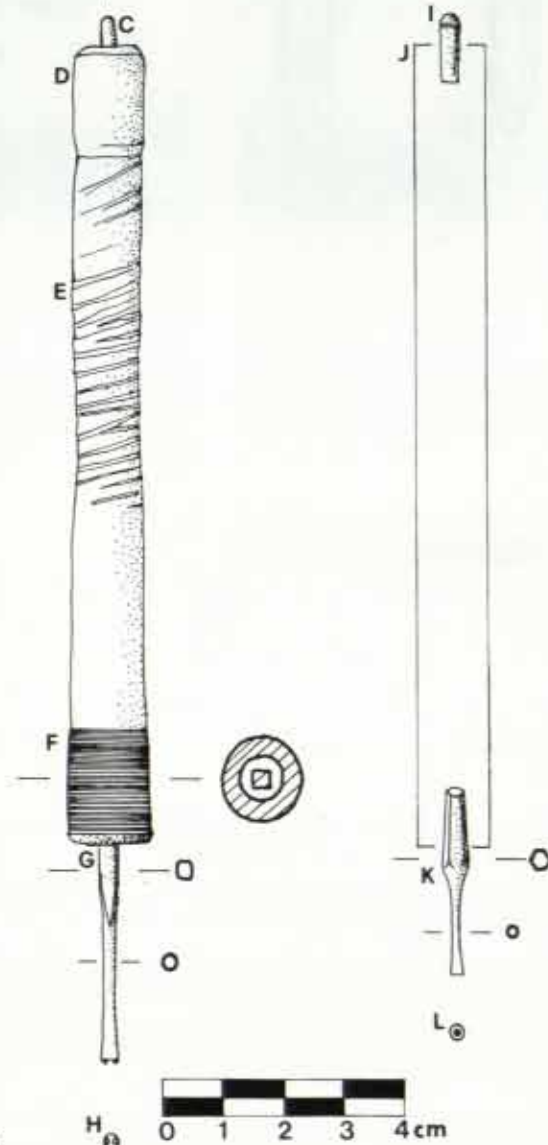
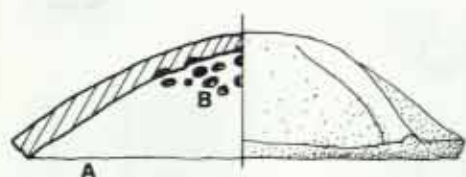


Fig. 66



Fig. 67



Fig. 68

**Figs. 64-65** Moenjodaro, MNSE Area. Particular of broken phtanite drill-heads re-utilized with function of upper drill pivot, recovered from the surface of the site.

**Fig. 66** Hypothetical of reconstruction of an Harappan drill based on the analogical comparisons with the drills nowadays used at Nagara (Gujarat, India): A. Coconut shell; B. Circular depressions left by the revolving pivot (C); C. Upper pivot in copper centered with the drill-head; E. Wooden haft (note the spirally-oriented wear traces left by the bow-string); F. Functional extremity of the drill-haft, covered with a thin coiling thread. The same thread (see the section) secures the drill-head in the haft hole; G. Drill-head manufactured out of an umbrella reed. The functional part of the tool is rounded before the point's utilization. H. Working end of the drill-head showing two diamond chips hammered into the tip. I. Broken phtanite drill re-utilized as upper pivot. Note the rounded wear trace on the tip. J. Analogical hypothesis on the dimensions of the wooden haft; K. Phtanite drill-head; L. Tip of the drill's working end showing the characteristic feature of the shallow hemispherical depression.

**Fig. 67** Moenjodaro. Hemispherical limestone cap studded with small pittings in the Moenjodaro Museum Reserve Collection (DK MM 653).

**Fig. 68** Moenjodaro. Close up of the pittings on the surface of the limestone cap reproduced in the preceding figure.

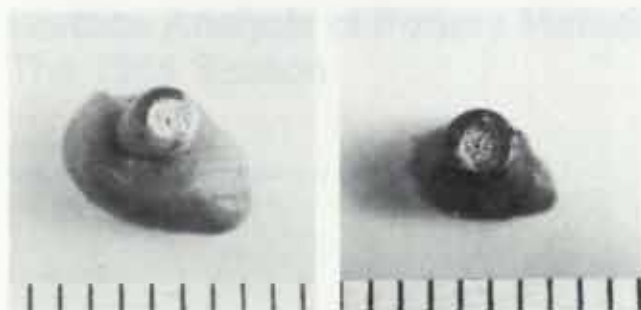


Fig. 69

Fig. 70

**Figs. 69, 70** Moenjodaro, MNSE Area. Particulars of the working end of phtanite drill-heads showing the distinctive shallow hemispherical depression.

**Fig. 71** Moenjodaro, MNSE Area. Unexploited lump (A) and broken chipped rough-outs (B, C) of banded chert for cube-shaped weight manufacture from the surface collection.

**Fig. 72** Moenjodaro, MNSE Area. Metamorphic rock splinters with polished or smoothed surface from the surface collection.

**Fig. 73** Moenjodaro, MNSE Area. Bronze/copper fragments from the surface of the site.

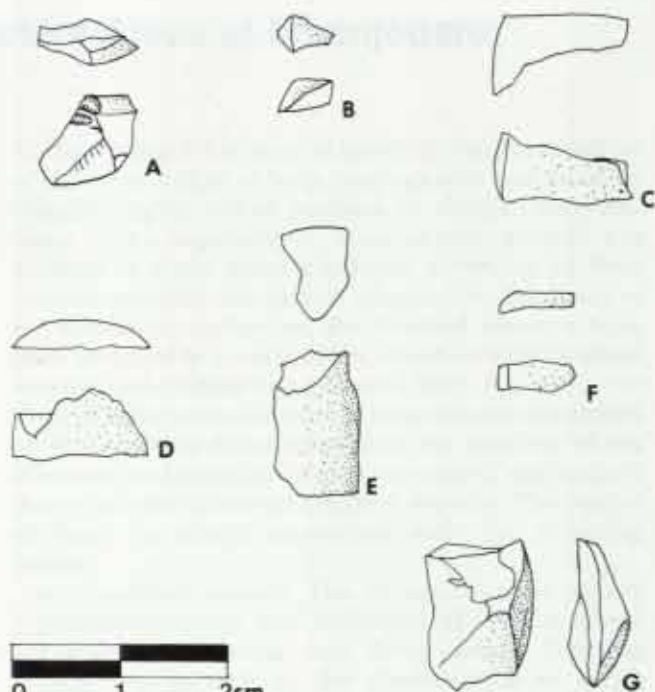


Fig. 72

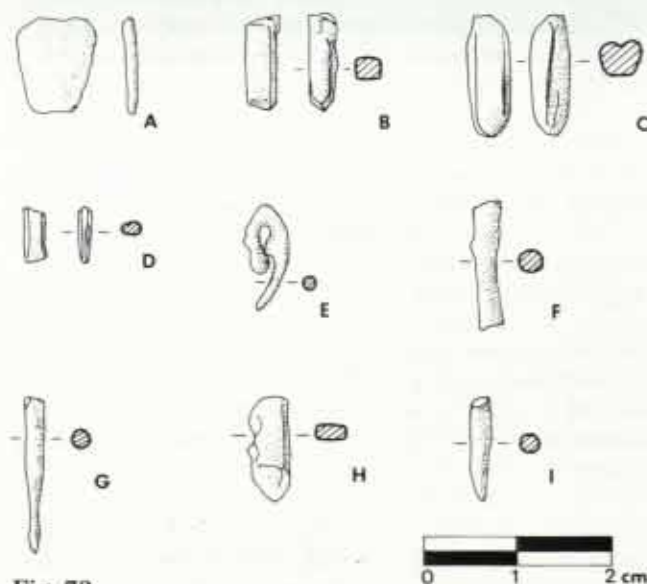


Fig. 73

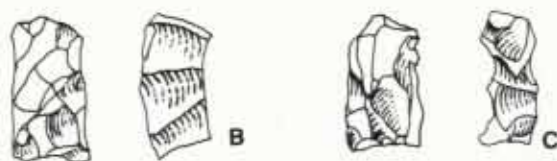
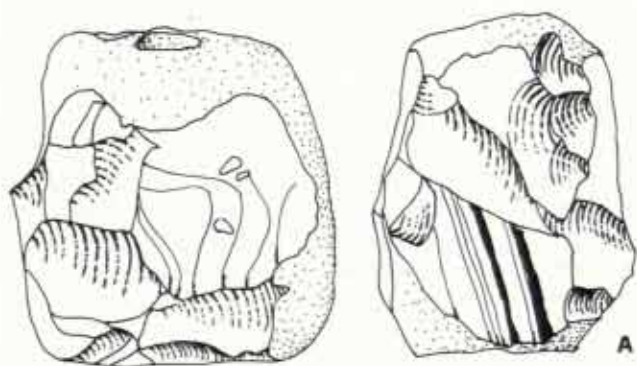


Fig. 71





# Surface Analysis of Pottery Manufacture Areas at Moenjodaro. The 1984 Season

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The aim of this paper is to outline aspects and first results of the investigation of the craft industry of pottery-making begun during the 1984 campaign at Moenjodaro as part of the broader Surface Evaluation Programme directed by M. Jansen and M. Tosi.<sup>1</sup>

This first investigation was designed to carry out observations, form hypotheses and to elaborate a strategy on which to base a future series of verification procedures; the present paper should be seen in this perspective. As some results have already been published (Pracchia et al. 1985), the emphasis is here on the operative aspects of the research with particular reference to stratigraphic and artefactual elements.

Up till now, the only available information we had on this manufacturing process at Moenjodaro was drawn from the earlier excavators' reports (Marshall 1931, Mackay 1938) where the references pertinent to a surface evaluation only deal with summary descriptions of recovered kilns and their location (Pracchia et al. 1985). Also almost totally absent from these reports are indications regarding the functional purpose of the relevant structure and the whole body of artefactual evidence that could help to define it.

In the course of the years of research, the examination of the huge heaps of both typologically and distributionally highly varied residues of vitrified clay that cover large expanses of unexcavated ground has resulted in their being classified according to their various possible functional origins. On the basis of the dominant indicators, the vitrified remains have been assigned to nodule floors, stoneware-firing waste spreads and pottery-firing dumps (*ibid.*: Fig. 1).

The 1984 analysis conducted on these remains was based on the working hypotheses that the position of the kilns can be determined by the presence of particularly dense concentrations of vitrified wasters. The project at hand is chiefly concerned with the following issues:

a. Locational aspects. The delimitation of pottery production areas, the definition of the functional variability (forming and firing areas, dumping locations) as well as the identification of single kilns, with the object of gaining information on the degree of labour organization (Tosi 1984, Vidale 1983, Bondioli et al. 1984).

b. Characteristics of the manufacturing processes. The form, nature and function of facilities and tools (from the morphology of kilns to the identification of specialized instruments); technological aspects of the transformational sequence (firing parameters, different stages of the process); the type and amount of products with specific reference to the specialization level of vessel production.

c. Chronology. The relative and absolute components of the exposed topsoil with the object of calculating the overall reading of surface evidence.

The evaluation of post-depositional events (i.e. the transformation dynamics affecting installations after abandonment) assumes particular relevance in this project, as it does for other manufacturing processes. In fact, it is compulsory to recognize these dynamics if we are to retrace the path leading from the present evidence back to its genetic roots. The investigation was conducted in three different areas, chosen (other than for the presence of vitrified remains) according to their geomorphological profiles: plateaus, hummocks, depressions etc. In all three cases, the relevant areas were mapped and stripped with a vacuum cleaner in units of 0.25 m<sup>2</sup> to a depth of about 0.20 m.

## Area south of DK-B-C (2820-1395)

The first of the tested squares, provisionally referred to as KAI, is located on top of one of the areas not altered by previous excavation activity. The deciding factor in the choice was to complete isolation of the

wasters with respect to the surrounding areas. The homogeneity of slags and potsherds on the surface, scattered over about 6 m<sup>2</sup> and decreasing in size and density from a central point, and the location of a very slight depression on top of the hummock would seem to indicate, with a high degree of probability, the presence of a kiln still in place, particularly in view of the fact that the level summit area of the site usually presents the most unsatisfactory conditions for a surface reading due to high frequentation and scarcity of erosive action. The map (Fig. 1) drawn up on the basis of the provisional operative morphological typology used previous year in the Moneer SE area (Bondioli et al. 1984: Fig. 6) reveals a rather select number of slags. Of the twelve types identified (Pracchia et al. 1985, Tab. 3), only three are present: overfired bricks, fracture surfaces and melted drops. These are normally found at the bottom of the lower kiln chamber, generally after the melting of the inner structural components of the kiln.

The first cleaning operation was undertaken to a depth of about 20 cms (Fig. 2) in order to compare the surface picture with the buried situation. The impression of homogeneity and the decreasing density of wasters noted on the surface corresponded in this case with the subsoil. The graphic representations (Figs. 3, 4) show the behaviour of the melted drops, expressed in absolute numerical frequency decreasing progressively from a central point. The same homogeneity was noted in the size of the slags, up to 5 cms approximately.

In the centre of the stripped area a row of decayed bricks was visible, arranged triangularly around an ash layer and with a filling containing fragmentary vessels (Fig. 5). The identified layers were then removed to avoid them decaying completely due to their proximity with the surface and also to gain a coherent picture of the evidence briefly described below.

#### Stratigraphic units of the kiln south of DK-B-C (Figs. 5, 6)

Sediment of silty-ash (2) presumably produced during the abandonment of the area and partially disturbed on the top by later erosion. The drops (3) distributed on the surface spread from this point.

Sediment produced by the disintegration of vessels shortly after abandonment and preserved in the kiln in fragmentary condition. Their state of preservation depends on the degree of protection offered by the sediment and on the proximity with the surface (Fig. 7). The only find that suggests their presence in the chamber during the last firing is the mouth of a jar (Fig. 8), highly vitrified on the side facing the ash layer (5). The position of (3) on the contrary, arranged between the stoke hole and the fire remains, indicates that this is not the original load of the kiln. On the top of the layer, a negative interface produced by later

erosion, a chaff-tempered clay object (Fig. 9) with a rounded structural side could be related to the original closing of the stoke hole.<sup>3</sup> The significant indications here are its dimensions, the overfiring of only one of the two faces, the absence of traces of applications serving as a lining on the walls, the lack of a plaster lining on the inner wall and a piece of the same material of the same thickness positioned between two bricks at the entrance. The pottery and related stratum is in direct contact with the lower layer. Even though this pottery can not be described definitively as a product of the kiln, the direct contact with the lower stratum indicates the pertinence of the vessels for the dating of the structure. The pottery found in layer (3) belongs to the late period of the settlement (Fig. 10) even though the merely partial control we have over the pottery sequence renders a satisfactory dating difficult to achieve.

(4) Thin deposit of melted drops produced during the last firing and buried under a few millimeters of the ash produced by the same firing (5).

(5) Ash layer containing immediately below its surface a carpet of melted drops. The edge of the stratum was damaged by erosion in recent times, and this caused the dispersion of drops noted on the surface.<sup>3</sup>

(6) Inner bottom of the kiln belonging to the last firing. It is composed of very compact clayish silt with traces of burnishing near the corners of the back side of the structure.

(7) Silt produced after the structure was abandoned. It covers the structure and is eroded on the top. Reddish in colour, it contains very sporadic small fragments of pottery and other artefacts.

(8) Kiln, see description below.

(9) Layer very similar to (7) but more compact and containing a high percentage of inclusions, mainly broken bricks. This could be a filling surrounding the kiln walls and this impression is confirmed by the contact, noted some centimeters south of the structure, between this stratum and (7) covering it. The filling surrounding the kiln corresponds to the ditch normally enclosing, in up-draught kilns, a firing chamber.

#### The Kiln (Figs. 5, 6)

Triangular in plan, the kiln is delimited by a single row of rectangular bricks belonging to later phases (Jansen, pers. comm.) which, judging by their fragmentary conditions, were probably re-utilized from other structures. The back of the kiln is re-enforced by four bricks lying side by side lengthways. On the sides of this pseudo-pillar are two recesses with vitrified surfaces like the inner walls which seem to indicate the original presence of two flues or chimneys. Furthermore, on the back of the kiln two large blocks of clay melted into place indicate the higher degree of heating of the

chamber at this point as would be expected near the chimney.<sup>4</sup>

The kiln, although comparable in shape with the examples known from Harappa (*Vats* 1940: 470-71) could, due to a series of details, belong to a horizontal type and not to the common up-draught structures normally met within the Indus Civilization. Factors which point towards this interpretational direction are the complete absence of vitrified material belonging to a middle floor and the absence of a central pillar or a wall tongue to sustain it. Other characteristics, if we compare this kiln with others of the postulated type, are the concave fire-place immediately behind the entrance, the inclined inner profile and the flues at the back.<sup>5</sup> The kiln, as already mentioned, seems to be surrounded by a filling (layer (9)).

#### Area south-east of A.A. 27 (2870-1030)

The area provisionally referred to as KAM is located south of the long hummock running eastwards from the excavated area of HR, not very far from the dam and the new channel surrounding the site. In a depression caused by recent earth-removing activities, a circular formation of about 3 m<sup>2</sup> of vitrified clay slugs was visible and it was easily recognizable as a kiln still in place (*Fig. 11*). In this case it was sufficient to clean the surface to a depth of no more than 10-15 cms in order to expose the complete perimeter of the structure. The information we had was of hardly any use in the evaluation of post-depositional events and the cleaning was executed in order to record the endangered structure and to obtain information on its characteristics.

#### The Kiln (*Figs. 12, 13*)

The exposed portion of the kiln belongs to the bottom of a firing chamber (the upper part probably disappeared with the recent lowering of the original level) measuring about 200 x 1,70 cms; the stoke hole is about 60 x 70 cms and is orientated south-east. The perimeter is constituted of a row of bricks, laid horizontally end to end. In the centre of it, in the same axis as the stoke hole, the tongue wall originally supporting the grid is visible. The inner wall is plastered with a chaff-tempered clay lining. At certain points at the back of the chamber, concentric lines indicate the possible restoration of the structure, alternatively they were simply formed by the collapse of the upper part. The bottom of the kiln is partially covered by a thin layer of greenish melted clay produced during firing. This should represent its final coating; as observed on the inner wall, (*Fig. 12*) the vitrified wall linings extend vertically under the melted

clay floor indicating the possible existence of previous levels of activity.<sup>6</sup> On the basis of normally observed requirements for preserving heat, the firing chamber must have originally been embedded in or surrounded by an earthen filling; an erect structure of these dimensions would be statically impossible with such thin walls. This type of kiln is comparable to the others discovered by the earlier excavators (*Marshall* 1931: 102, Pl. LV16; 225-6, Pl. LVIIIb) and more generally to others known from the Indus Civilization (*Balakot, Dales* 1974: 10, *Fig. 7*; *Lothal, Rao* 1979: 83, 118, *Fig. 11, 12*; Pls. XXXVIb, XCIa, b). In this case the chronological and functional classification is problematic due to the scarcity of associated finds. The use of the kiln for firing pottery can only be concluded empirically and the few overfired clay specimens can be associated with it only because they are superimposed, which does not favour any well-founded chronology. For the moment we are unable to decide whether the isolation of the structure has been brought about artificially by recent activities or not.

#### A.A. 32 (2250-1845)

The third survey was carried out within the larger area usually attributed to pottery manufacture (*Bondioli et al.* 1984: 29). The area lies to the north of DK-G excavation where Mackay found at least six kilns belonging to the town's last period (*Mackay* 1938: 6). The presence of kilns among the partially abandoned houses of previous periods, the clay waster filling of building trenches and the diffusion of slugs and pottery remains on the surfaces around the excavation have been traditionally seen as indications of a later functional change from a residential to a craft area. The slag concentration chosen for testing crowns the top of a small hummock and, like that south of DK-B-C, the elements forming it decreased in frequency and size from a central point (*Fig. 14*). As with the other case a map was drawn up and the surface was stripped to a depth of about 20 cms (*Fig. 15*). The removed deposit was composed of thin superimposed strata, distinguishable only by a slight chromatic variation in the silt matrix. Layers (2), (3) and (4) were characterized by a high concentration of inclusions such as fragmentary bricks, slugs, overfired potsherds and, occasionally, bones. Layer (11) was mainly composed of broken bricks (*Fig. 16*).

All the tested deposit from the surface to a depth of 2-5 cms had been homogenized by erosive action and weathering. There was a marked contrast between the quantities of wasters visible on the surface and contained in the deposit below it. Here the frequency of slugs was in fact very low compared to the high concentration noted on the surface. The post-depositional process leading to the observed evidence has been empirically reconstructed as follows.

### Formation of slag carpets on the surface (Fig. 17)

The surface appears to be a negative interface produced by water erosion and eolic deflation on the refuse deposits forming the upper levels of the hummock (Fig. 17a). The combined actions of these agents had progressively lowered the deposit by removing the silt but leaving the heavier inclusions, among them slags and overfired potsherds (Fig. 17b). The exposed slags have been progressively broken by thermal dilation combined with salt efflorescence (Fig. 17c). The non-overfired inclusions such as potsherds and bricks are embedded in a sediment which was gradually carried away by erosion. Sometimes, crumbled slags are found trapped in eroded gullies. In any case, the result is a concentration of wasters and rare traces of barely identifiable clay remains. Their regular and concentrated distribution is, in this case, more apparent than real and is confined to the surface as their presence in the subsoil is extremely random (Fig. 17d).

### The exposed horizontal stratigraphy in A.A. 32

Under the refuse layers (Fig. 18) lie the traces of some kind of structures, evidenced by scantiest remains. On a subhorizontal layer (7), a residual row of bricks is visible (6). A mud clay floor (5) and a trodden plain (13) composed of densely compacted sediment are the other elements associated with the decaying or the robbery of bricks by the collapsed stratum (11). Layer (14) does not present traces of wasters arising from firing activity and the same applies to all the other horizontal stratigraphic units. The general impression gained is, judging by the excavation data, that of a badly damaged habitation level used in a later phase as a dump area.

### Observations on phenomenological characteristics of surface waster concentrations.

Although the distribution observed south of DK-B-C and here in A.A. 32 appears very similar, a closer inspection of the quantitative and qualitative aspects of overfired clay specimens reveals some differences. In the case of melted drops, for example, their distribution (Fig. 19) is totally different from that of DK-B-C (Fig. 14). Although the two diagrams are not strictly comparable as one is expressed in numeric values and the other in ponderal values, they are, however, evidence of the difference in terms of presence/absence and increase/decrease as against random distribution. The same impression of stochastic behaviour is obtained from an evaluation of the ponderal values of slags found to a depth of less than about 5 cms (Fig. 20).

### Examination of single residues from A.A. 32

The careful observation of selected slags provided information concerning the construction characteristics of kilns and types of products present in the area. In the case of one example (Figs. 21, 22) its present condition may have been caused by a traumatic event during firing.<sup>7</sup> It is part of a grate composed of small bricks on top of which the original floor of the firing chamber, plastered with a chaff-tempered clay lining, was sealed by melting vessels. Another specimen (Fig. 23) shows a pile of melted beakers in contact with some nodules whose function has not been precisely defined (Pracchia et al. 1985, see note 4).<sup>8</sup> In this specimen the cohering elements can be read in two ways: as a product together with the beakers or as setters or distancers,<sup>9</sup> to support the vessels and to protect them from smoke effects.<sup>10</sup>

The high occurrence of potsherds in the refuse layers could give us some idea of types of kiln-produced pottery and of the ceramic range of the late period. Five of the most common shapes encountered are listed on Fig. 24 and the percentage value of their occurrence is expressed in the relative diagram. The illustrated sample, about 200 fragments, is too small and the area too restricted to enable us to hazard any inference on the frequency of types, but the evidenced ratio between beakers and jars roughly confirms the impression gained by simply observing the surface.

### Conclusions

The observations reported in this paper represent the fruit of the first study during the 1984 season of pottery-manufacture at Moenjodaro. The analysis of the complex phenomenology of vitrified remains furnished a set of working tools for use in the investigation. The first operational instrument was the morphological typology of overfired slags empirically organized to control, as closely as possible, the variability of the topsoil subjected to analysis. For this purpose the various specimens have been sorted on the basis of observed primary situations and attributed to various parts of kilns with different degrees of vitrification (the list of identified AICA<sup>11</sup> and the operative typology are shown in Pracchia et al. 1985: Tabs. 2, 3).

Compared to the large amount of available evidence the examined samples are still too few to allow us to hazard a general picture of the nature of pottery production. The first observations made in the field together with the data made available from the excavations of the first half of the century seem to confirm the existence, in the late period, of two different types of labour organization evidenced by differences in kiln construction and in their residual products. Isolated structures like the two observed during the '84

campaign or those found during the excavations in residential areas (Marshall 1931: 225-6, Pl. LVIIIb), compared with the finds of clusters of kilns and enormous amounts of wasters, led us to think of domestic versus industrial production (Fig. 25). On the other hand, our partial knowledge of the Harappan pottery chronological sequence and the indefinite nature of the stratigraphic evidence from the earlier locations does not fully justify the presumed contemporaneity of the two systems. It is therefore difficult to decide whether the six kilns discovered by Mackay were in operation together or whether this impression arises simply because they generally belong to late levels.

Exploration in various eastern settlements has revealed, in conjunction with periods of considerable urban development, industrial areas for pottery manufacture crowded with a high number of kilns.<sup>12</sup> In regard to the six kilns it is still doubtful — at least on the basis of observations in A.A. 32 — that a major factor in the hypothetical mass production is the high resistance of vitrified clay residues to natural and anthropic degrading action. The impression (still to be confirmed) of the variability of the pottery heaps in dump areas could be, however, for the type of production, just that made by the late period of the settlement. For clues to the labour organization of previous periods such as that hypothesized for brick production (Pracchia et al. s.d.) the possible industrial quarters satisfying the demands of such an urban center have to be sought far from the actual perimeter of the compound because of the strong atmospheric and thermic pollution produced by the firing installations.<sup>13</sup> Whatever the degree of accuracy in the analyses and the possible inferences we can draw, the picture that begins to emerge from the surface evaluation of pottery manufacture areas seems to relate mainly to the later phases of the settlement. On the other hand, we have few possibilities of detecting areas belonging to previous periods, as in the case of other types of manufacture, because of the apparent lack of original evidence within the present visible perimeter of the town. We shall address our future research to this aspect, which is particularly meaningful for the whole picture of craft production at Moenjodaro obtainable from the surface record.

## Footnotes

- 1 All methodological statements in the present work are to be referred to the general aims of the project expressed in Bondioli et al. 1984 and refined by the authors across the experiences of the field activity at Moenjodaro and other sites, mainly in the Iranian plateau. We will avoid here, except for strictly technical topics, continuous citations of the mentioned work, starting point of the whole programme regarding surface evaluation.
- 2 As observed directly in the Lal Shah kilns at Mehrgarh (Pracchia s.d.) and in the following example, the chaff-tempered clay lining is frequently employed to plaster the inner walls of the firing chamber in up-draught kilns.
- 3 This particular example demonstrates the stratigraphical paradox of the same layer (5), covering and being covered by another layer.
- 4 The morphology of these two slags is different from that observed on the surface.
- 5 Comparable structural types have been encountered, but very distant in time and space (Barnard 1976: 22, figs. 14-15); the horizontal shape and the relative draught of hot air from the entrance directly to the chimney at the back side is a device that enables for increased temperature and, in case of pottery making, the optimization of the fuel used for heating.
- 6 It is possible, as observed during the '85 season at Mehrgarh in one of the excavated Lal Shah kilns, that in some cases the lower floor grows in time according to different restorations.
- 7 It can be supposed that parts of slags and overfired pottery fragments are normally produced during the firing and thrown on refuse areas after periodical cleaning. Sometimes, as in this case, the firing causes accidents involving the whole kiln.
- 8 The only established function is a filling under the pavements of later buildings (Mackay 1938: 85). The enormous amounts of such nodules in many parts of the site surface, however, suggest some other unidentified use.
- 9 The use at Moenjodaro of devices to support the vessel during firing is documented in a possible saggar (Halim-Vidale 1984). In this case terracotta bangles were used.
- 10 Shepard 1976: 92
- 11 Archaeological Indicators of Craft Activity following Tosi's definition (Bondioli et al. 1984).
- 12 Fifty kilns from tepe Rud-i Biyaban 2 (Tosi 1984: 42); sixty from Altyn Depe (Kohl 1984: 127). The first sounding at Lal Shah hill near Mehrgarh revealed six different kilns clustered within an area of about 50 m<sup>2</sup> (Pracchia, Excavations of a Bronze Age Manufacturing Area; in press)
- 13 For examples of peripheric industrial area cf. Mundigak, Nuzi, Altyn Depe, Outch Depe (citing Delcroix-Huot 1972: 81), tepe Dash (Biscione et al 1975: 40-41; Tosi 1984: 42, fig. 57; Mariani 1984) and Lal Shah-Mehrgarh (Pracchia s.d.). For Chanhu daro Mackay (Mackay 1943: 70) noted that: "No kilns that could have been used for pottery have as yet come to light at Chanhu-daro, probably because they were placed well outside the city."

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Fig. 1 Spread of overfired clay specimens in the area south of DK-B-C.

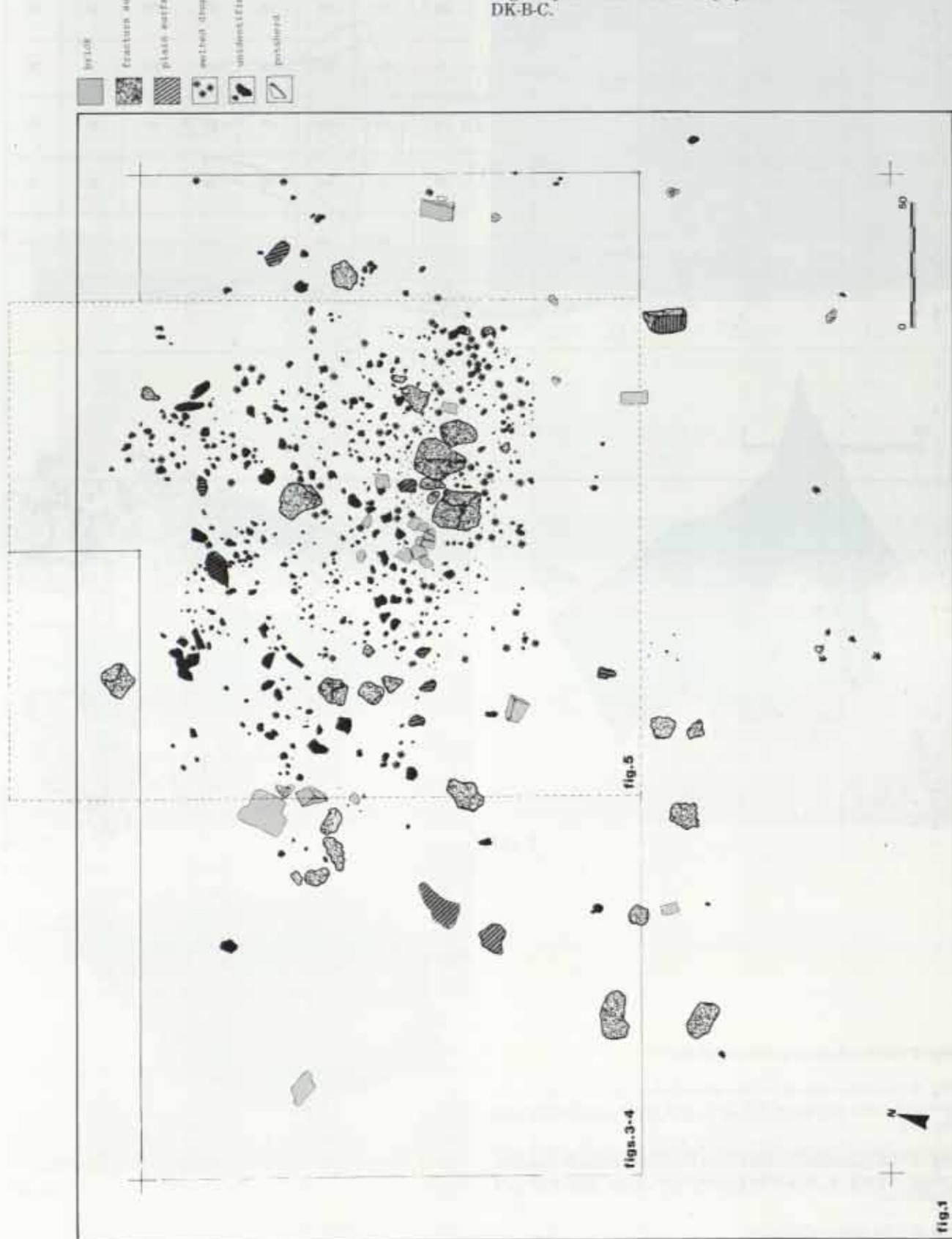




Fig. 2

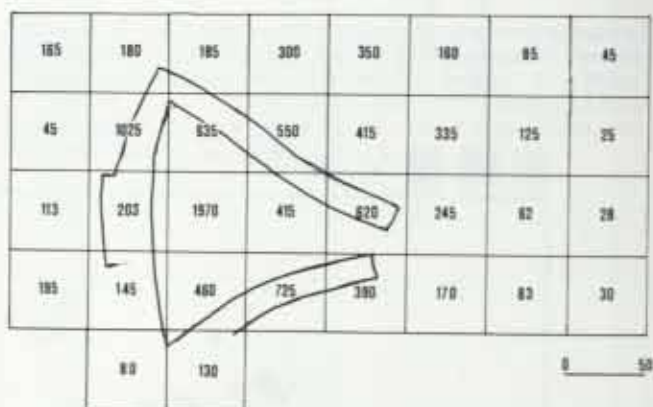


Fig. 3

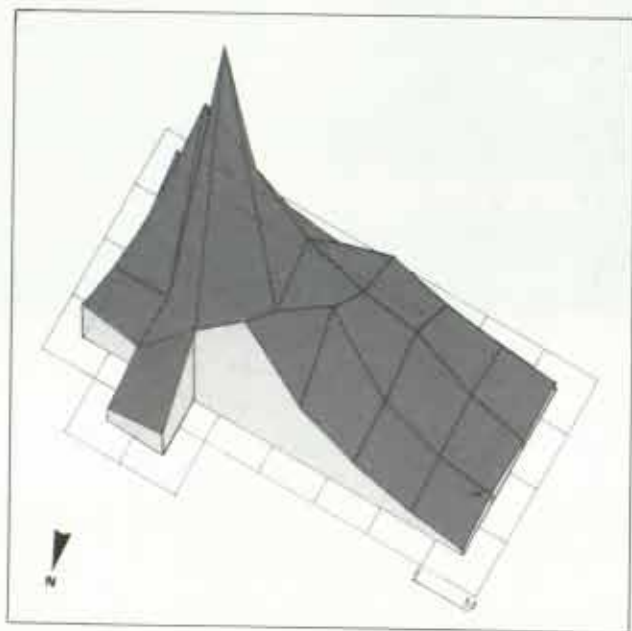


Fig. 4

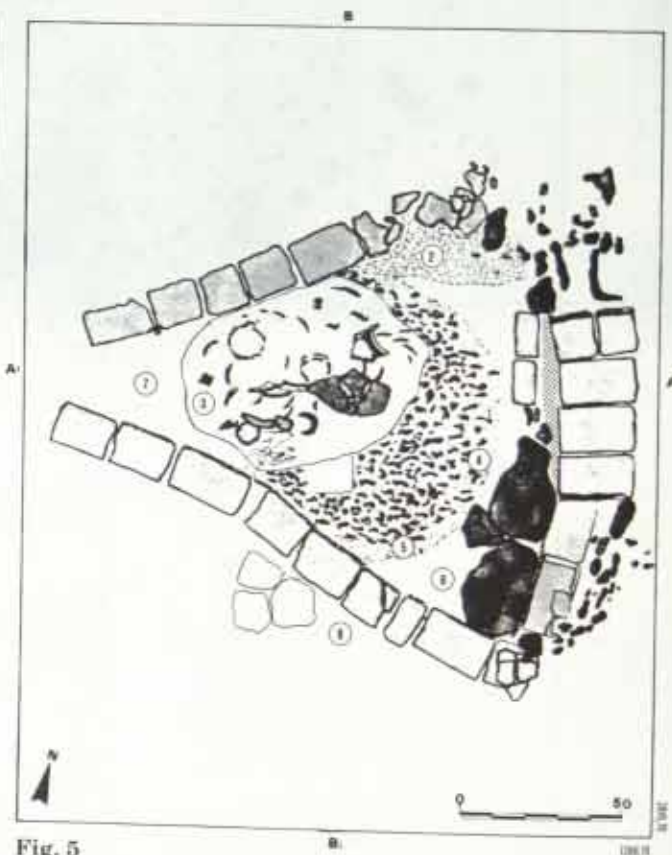


Fig. 5

Fig. 2 First stripping south of DK-B-C.

Fig. 3 Absolute numeric value of melted drops recovered from sampled area south of DK-B-C and their localization on the grid.

Fig. 4 The quantitative behaviour of melted drops in absolute values shows a progressive decrease from the point of irradiation.

Fig. 5 Kiln south of DK-B-C.

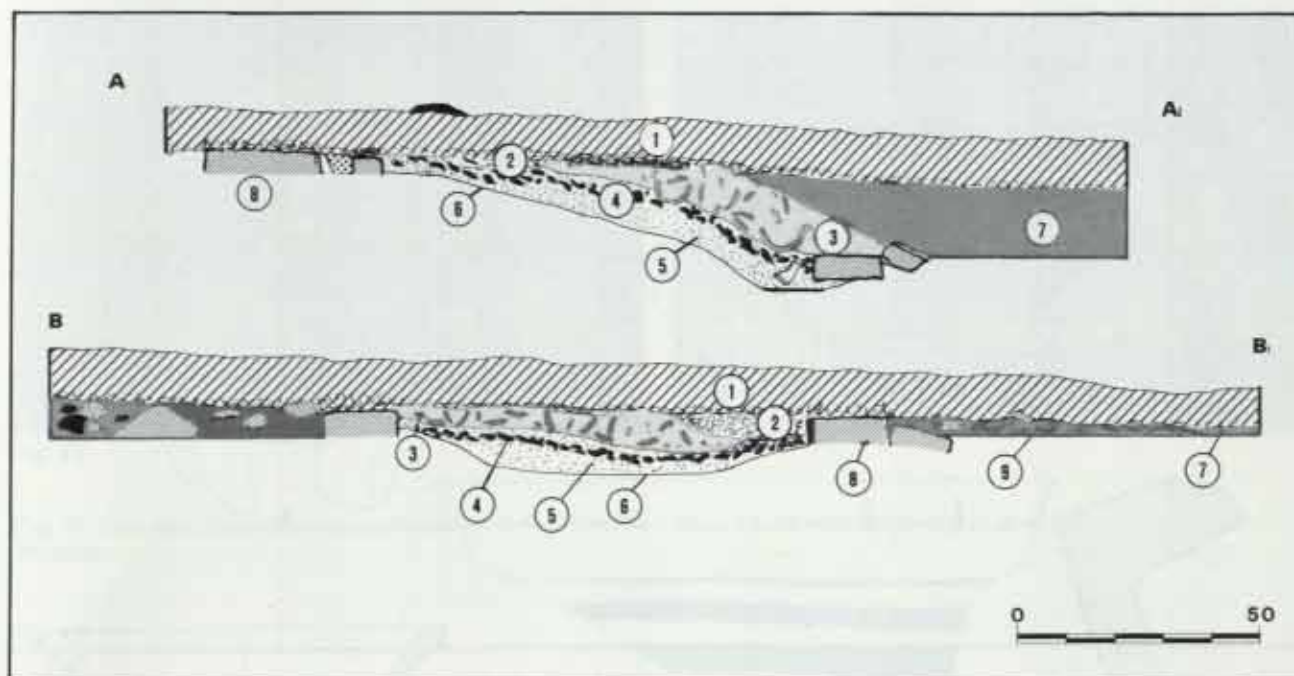


Fig. 6



Fig. 7



Fig. 8



Fig. 9

Fig. 6 Sections of tested area south of DK-B-C.

Fig. 7 Small pot progressively decayed towards the soil surface.

Fig. 8 Fragmentary jar gradually vitrified (from right to left).

Fig. 9 Chaff-tempered clay fragment.

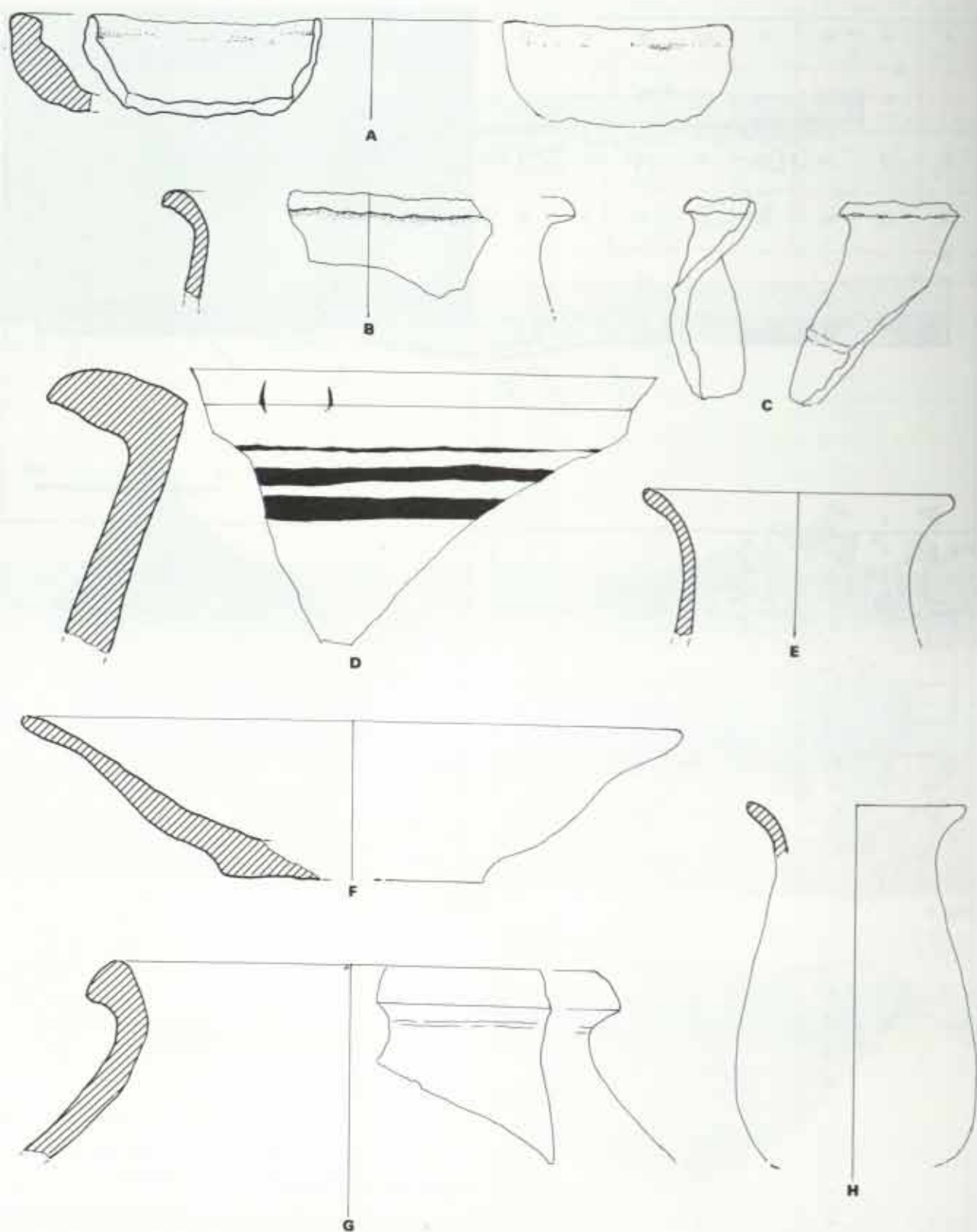


Fig. 10 Selection of fragmentary vessels forming layer (3) from tested area south of DK-B-C.



Fig. 11

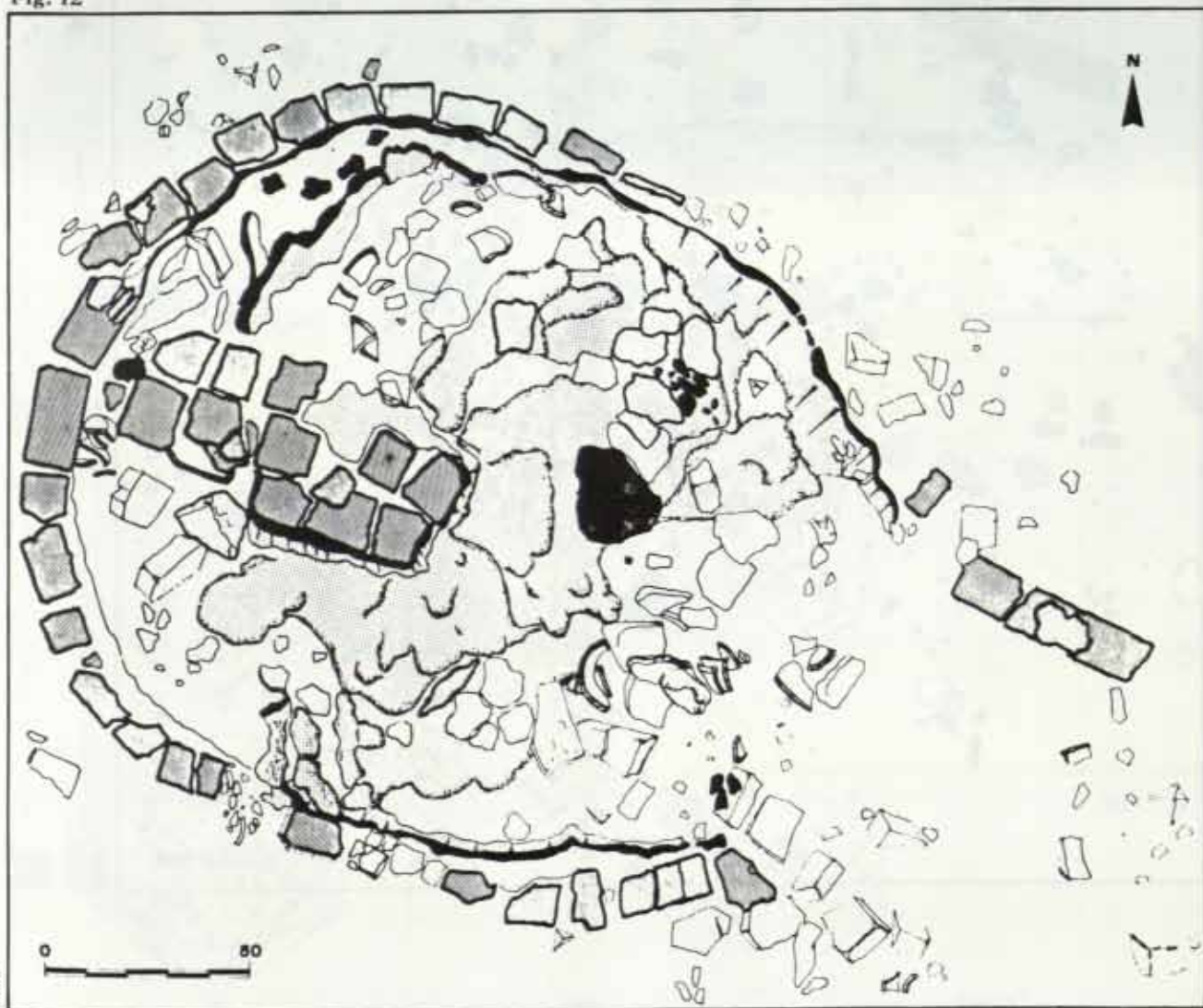


Fig. 13

Fig. 11 Clay slag concentration south-east of A.A. 27 before cleaning.

Figs. 12-13 Kiln south-east of A.A. 27.

Fig. 12



12/04/02

11/29/02

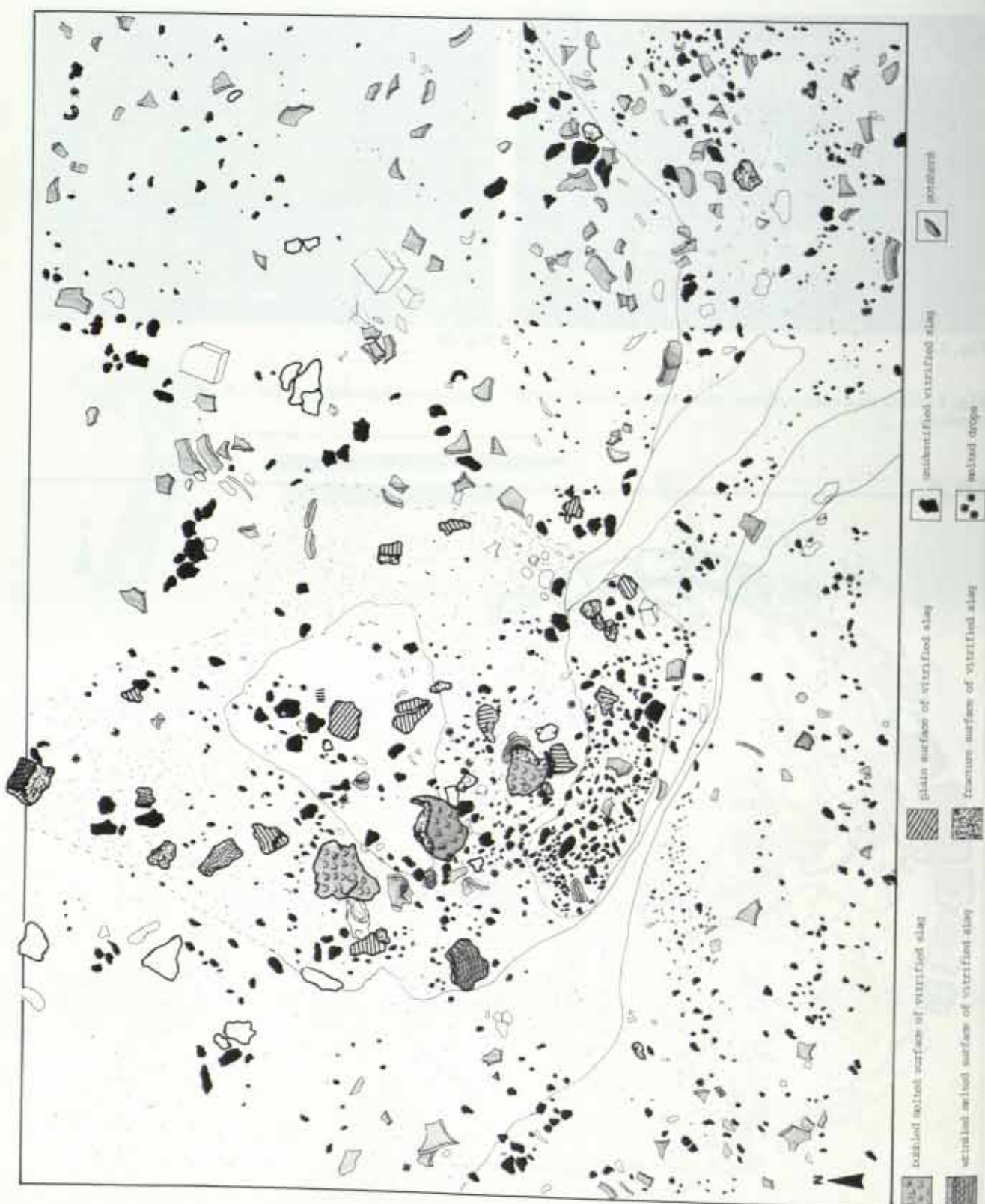


Fig. 14 Cluster of vitrified clay specimens within A.A. 32.



Fig. 15

Fig. 15 Strip trench north of DK-G showing layer (11).

Fig. 16 Cross sections of tested area within A.A. 32.

Fig. 17 Formation of overfired clay concentration as a result of the lowering of the deposit containing it due to the action of water and gravitational agents.

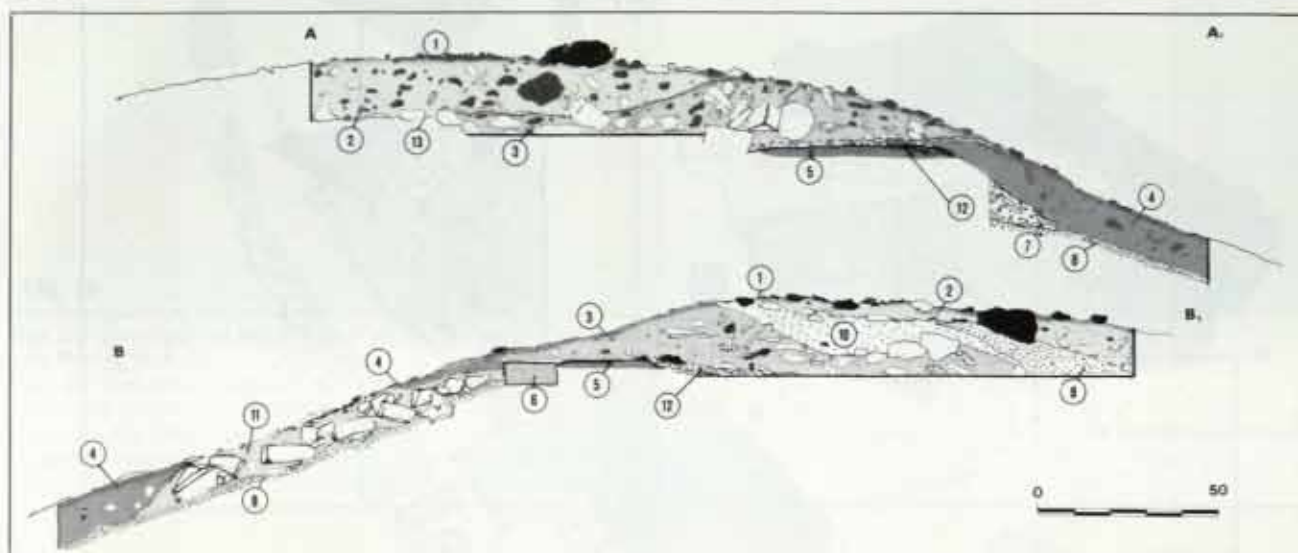


Fig. 16

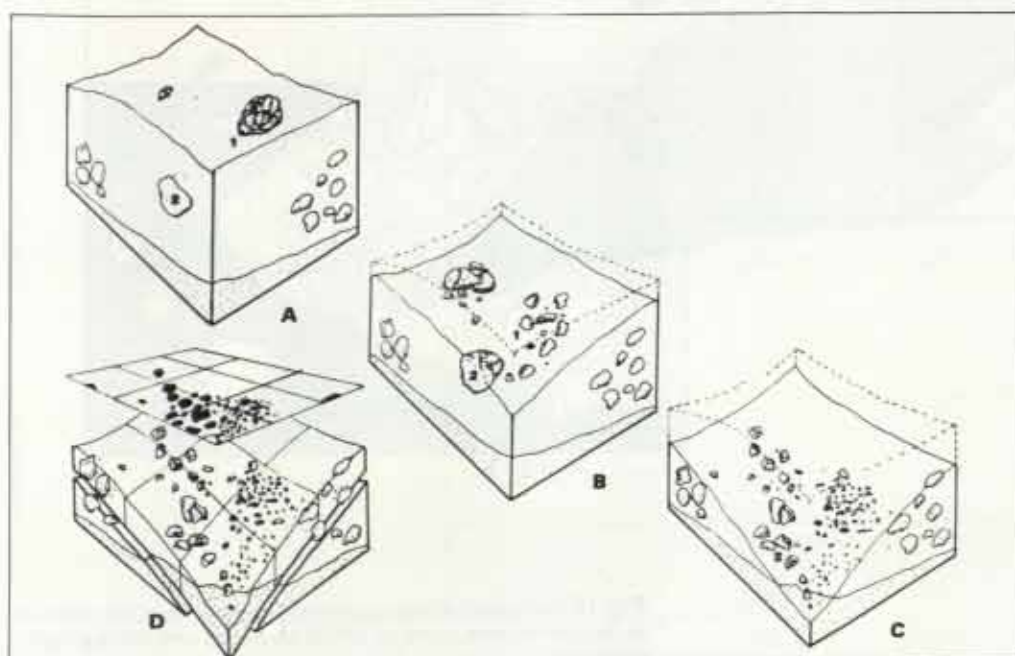


Fig. 17

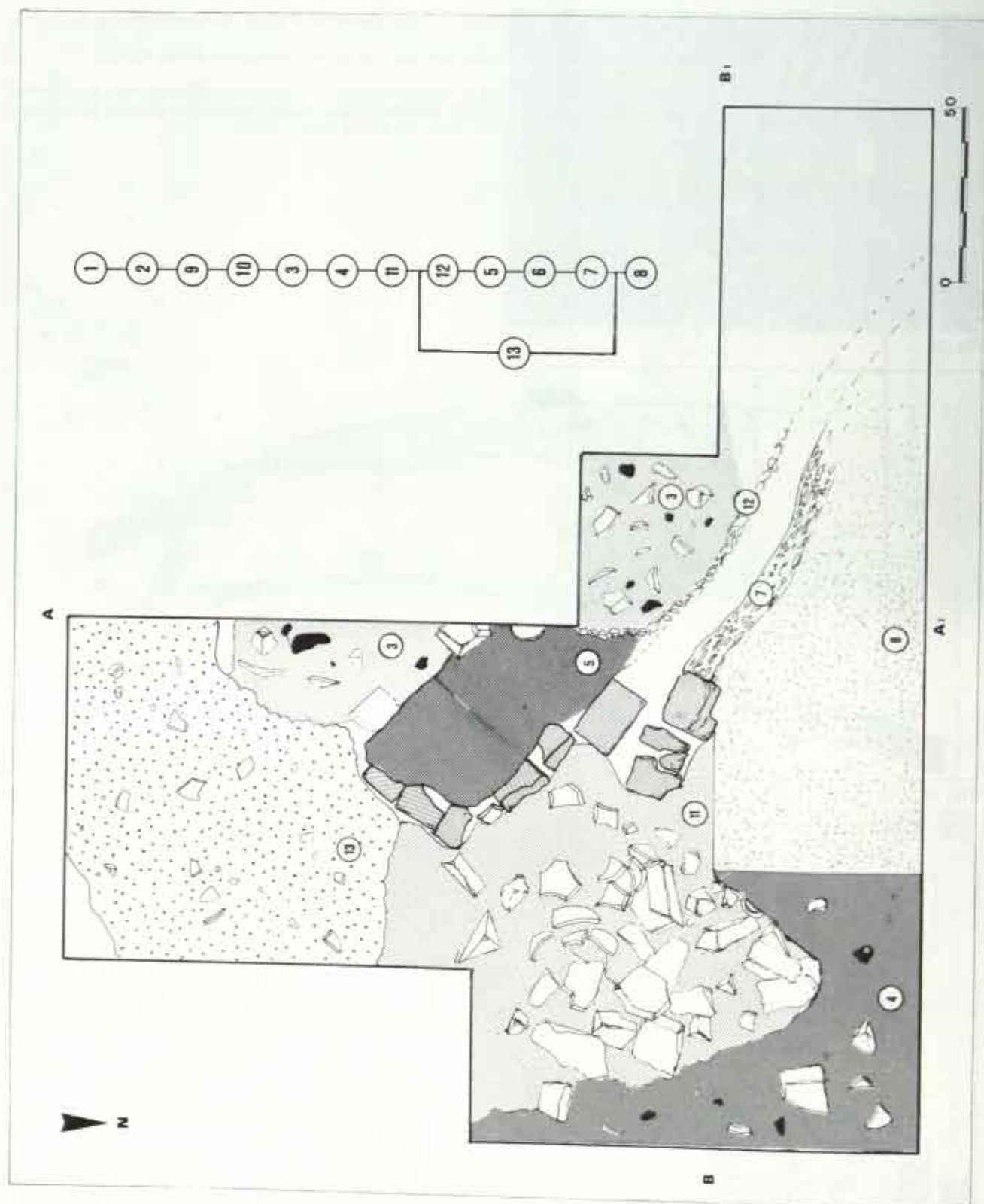


Fig. 18 Horizontal stratigraphy evidenced by surface cleaning in the tested area north of DK-G (A.A. 32) and stratigraphic sequence.

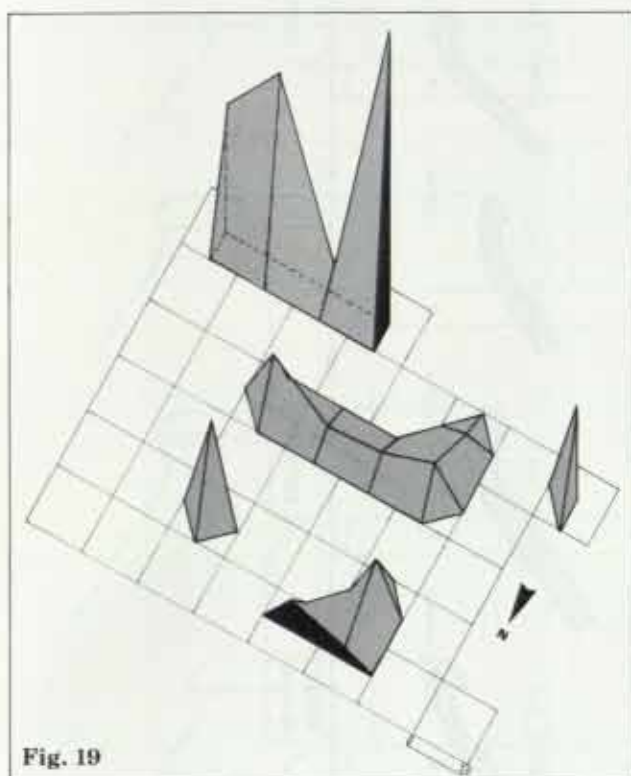


Fig. 19

Fig. 19 Quantitative behaviour of melted drops in the tested area within A.A. 32.

Fig. 20 Ponderal value of all the types of overfired clay specimens present in the tested area within A.A. 32.

Figs. 21-22 Clay slag from area north of DK-G (A.A. 32) showing vessels melted on the grate of an up-draught kiln. 1-melted beakers. 2-chaff-tempered clay lining. 3-small bricks.



Fig. 21

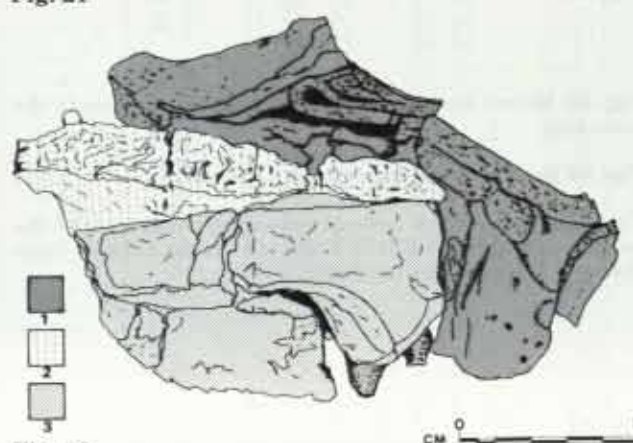


Fig. 22

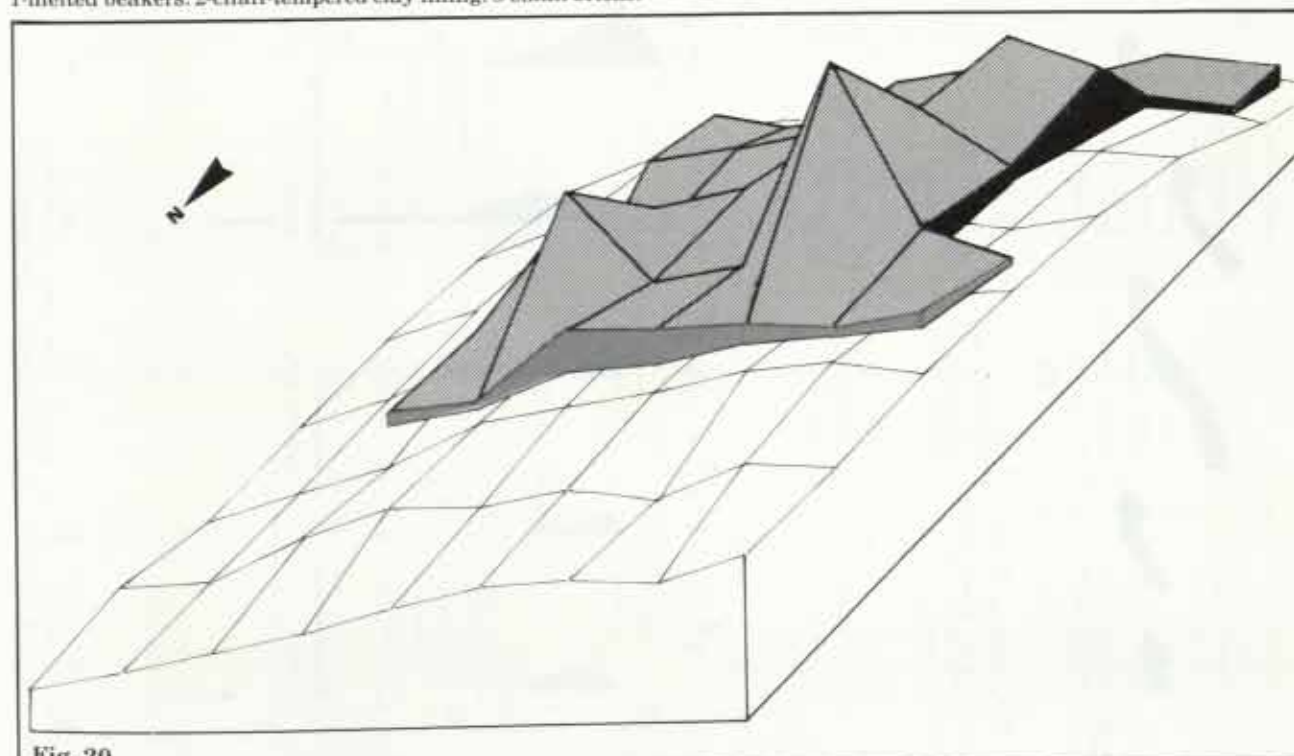


Fig. 20



Fig. 23

Fig. 23 Melted beakers and nodules melted together in the same slag.

Fig. 24 Beakers from refuse dump north of DK-G.

Fig. 25 Fragmentary beakers belonging to layer (5) of the tested area south of DK-B-C. The types are the same as those observed in refuse area north of DK-G.

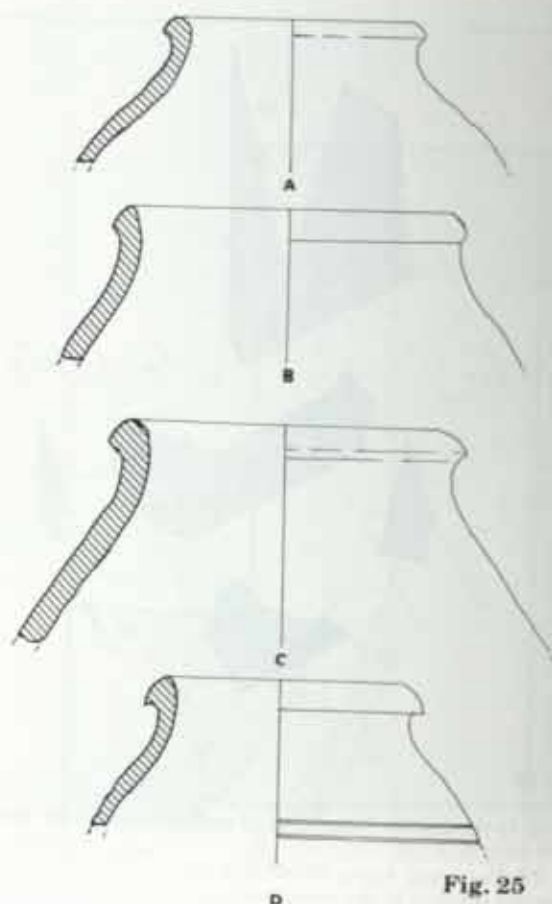
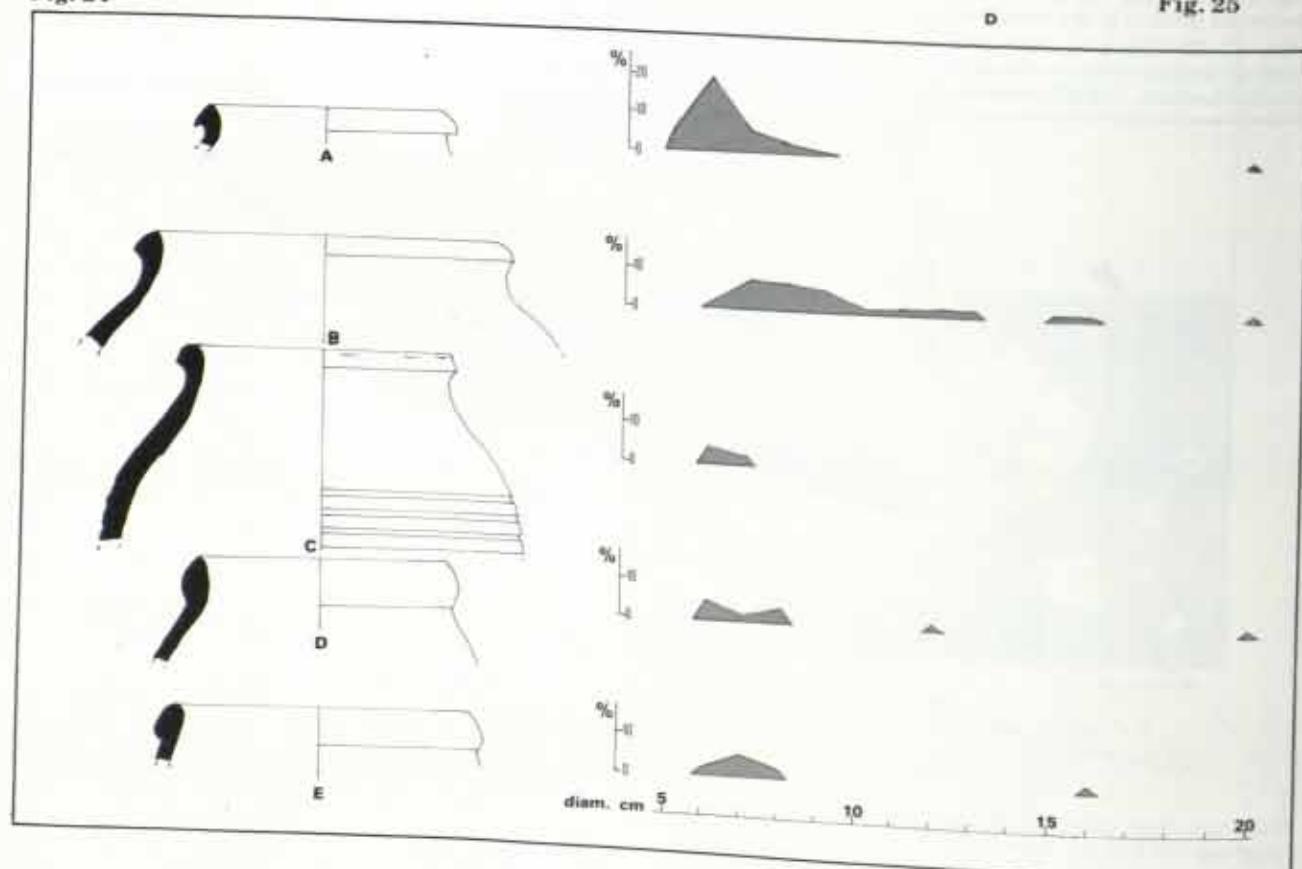


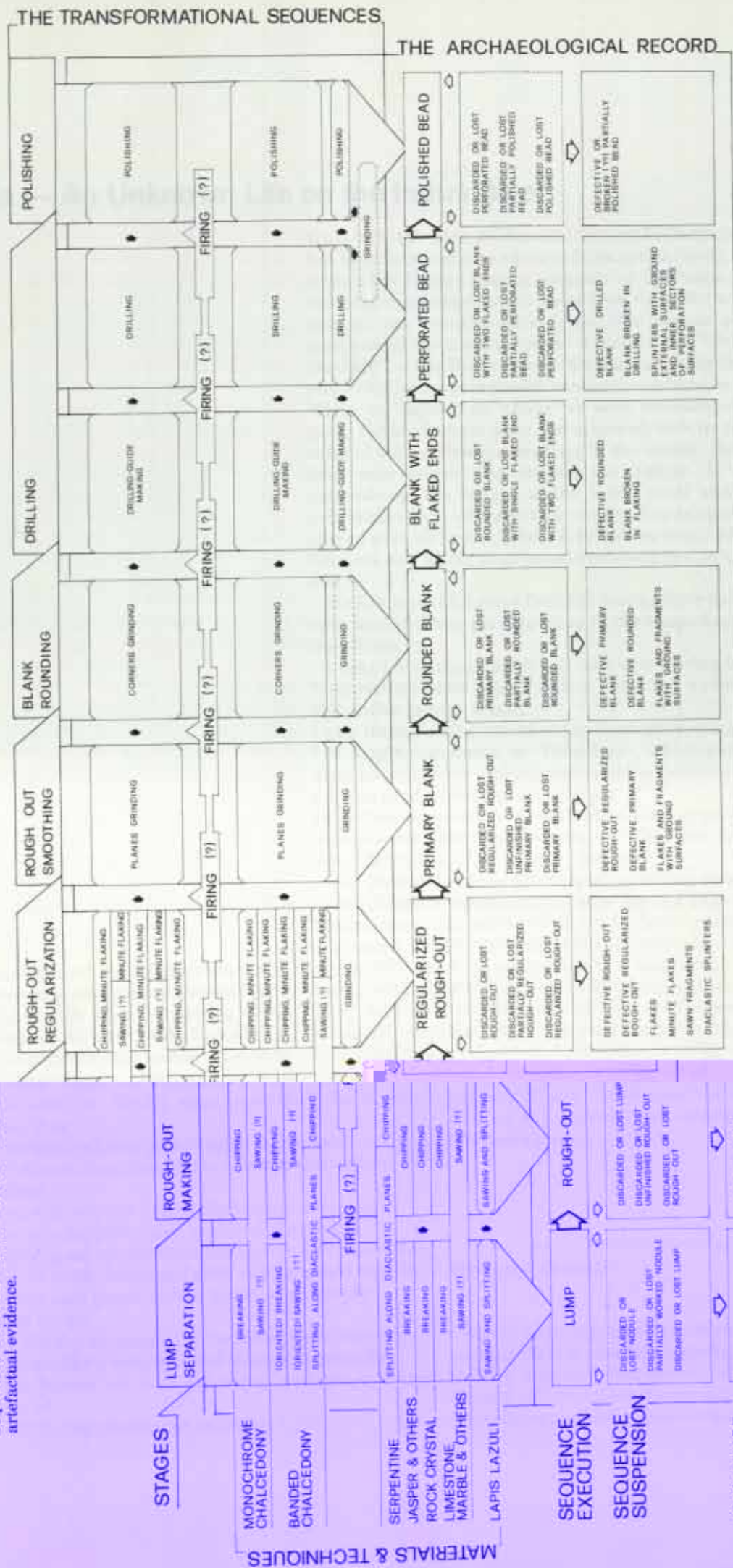
Fig. 25

Fig. 24



informational  
and the relative

Fig. 26 Flow diagram representing the transformational sequences recorded in the MNSE Area and the archaeological record.





# The Mohanna — An Unknown Life on the Indus River

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Since 1979 the German Research Project Mohenjo-Daro has been carrying out a survey of this ancient town, and since 1980 I have been a member of this team. On weekend evenings we made many trips to nearby areas, and on one evening during the 1980 season some members of the team proposed a visit to the "*Sindho Daryah*" — the Indus River. We passed along dusty paths and by dense tamarisk bushes to reach the Indus. When we reached its banks we were surrounded by green fields of wheat, peas and mustard, with its thick tufts of yellow flowers swaying in the breeze. Honey bees were murmuring around the Yaktar. It was astonishing, the beauty of the Indus itself and the perfumed smell in the air of the various flowering crops spread over its banks. About 5-10 metres from the left bank we saw about 15-20 boats anchored in a straight line.

We saw some Mohanna families casting their fishing nets, and children playing close to the house boats of the village.

I asked a young peasant boy who was scaring birds from the crops of wheat with a sling the name the Mohannas gave to a boat.

I saw them making use of old technology, rowing the 6 m long house boats, or "Doondees", which provide them not only with cooking and sleeping facilities, but are also used for sailing and fishing.

Since time immemorial the Mohannas as a caste have been named after their profession. They are fishermen, "Mirbahar", and sailors, "Mallah".

The Mohanna are a shy people, unwilling to show their villages to strangers, but after several trips they became more open and I was allowed to look around the settlement. I went there from time to time to collect data and to take some measurements of a boat which was being constructed at that time by Mohanna carpenters. They told me that because of the ever-worsening economic conditions they are considering giving up their hereditary occupation. Embroidery and the art of Sindhi blanket making have already disappeared. Because of this I have made a study of the origins as well as the cultural and economic situation of the Mohanna people.

## Introduction

Standing on the Stupa mound in Mohan-jo-Daro and surveying the surrounding countryside the visitor to this ancient ruin is met with an awe-inspiring sight. About 1500 m to the east of the city lies the Indus river, and his curiosity to experience this wonder of nature at closer hand is immediately aroused. Rigveda Sindhukshit, a Sindhi sage, described the Sindhu (Indus) thus:

"Flashing, whitely gleaming in mightiness,  
She moves along her ample volumes through the realms,  
Most active of the active, Sindhu unrestrained,  
Like to a dappled mare, beautiful, fair to see.  
Rich in good steeds is Sindhu, rich in cars and robes.  
Rich in nobly fashioned gold, rich in ample wealth,  
Rich in lush grass, rich in lovely wool, rich in sweet syrup.  
The Sindhu shining with the reflection of sun rays  
It seems like a wide sheet of silver and beautiful  
With forests on both its sides, and green crops watered  
With the inundations of its banks."

## Myths and Legends

Two old men from this same Mohanna village told me some of their myths and legends. Concerning Mohan-jo-Daro they said that nobody wished to settle on the Mohan-jo-Daro ruins because they had heard from their forefathers and had experienced themselves that when

people crossed the ruins their faces and hands turned blue. This is because an evil spirit is in possession of the ruins. Bricks and other things are not taken from the ruins for the same reason.

When asked about the custom of money which is given by people to the owner of a boat or at a marriage ceremony, called "*Ghoor*" in Sindhi, they replied that this custom is very old. Take for example the houses in Mohan-jo-Daro. The costs were not borne solely by the owner; rather each inhabitant was bound to donate one brick per head when someone wished to build a new house. (The origin of this Sindhi word "*Ghoor*" is an offering given to a poor person in the name of a deity.) It is an old custom that one man's burdens be shared by many.

It operates along the same lines as a bank deposit, which is then paid out on such occasions.

The Indus River is given the title "*Khuwaja Khezer*" or "*Daryah Badshah*", the "*King River*", because of the sacred power they believe is contained in its water. It is sacred not only because it is their source of survival and provides them with shelter, but also because it is endowed with spiritual power. If anyone drinks the water as a child, then he will be protected from evil spirits. That is why the children of the village are given the water to drink, it is a sort of good-luck charm. The Indus is so generous that all who come here will have all their wishes fulfilled.

Another myth is built around the ferries. In the Muslim belief the ferry is considered as the "*Pul Sarat*", a bridge over which they could pass into paradise. Therefore nobody avoids paying the toll.

They also believe that the "*Sarenh*" or Albizzia lebbec tree is sacred because when its leaves wither, or more accurately close, in the afternoon, this is a sign that it has caught the fever of the prophet. When they themselves catch fever then they wear the bark of this tree as a good-luck charm around their necks.

Another genus of tree, the pipal tree ("*Peperu*") is said to be a genie's tree, i. e. a place where a genie lives. They avoid going anywhere near this sort of tree.

## Geographical Context

The Mohannas are a caste named after their occupations of fishing and sailing. They can actually be subdivided into two castes:

- 1) "*Mir Bahar*" — fishermen, only concerned with fishing
- 2) "*Mallah*" — boatmen, only concerned with navigation.

The Mohanna fishermen and sailors also spend a certain amount of time bird-hunting.

The women of the village can usually be found making straw mats, baskets or engaged in other minor handicrafts.

In the Sind area, Mohannas can be found the whole length of the Indus River as well as some eastern parts of the Nara, on the Manchar lake, Keenjhar lake and many other small lakes in this area. According to a report in the Sindhi daily newspaper "*Hillal-e-Pakistan*" in February 1984, they number about 117 000. Before the arrival of the British in 1843, the whole of Sind commerce depended on their "*Doondees*" and other ships.

The Indus is fed by the melting snow of the Himalayas, and then passes through Kashmir, N.W.F. Province and the Punjab before entering Sind. It flows from North/North-East, meandering through its alluvial plain in a South/South-West direction and finally enters the Arabian Sea. Sail-boats are benefited by northerly monsoon winds in the winter, and southerly ones in the summer, thus allowing them to pendulate back and forth with relative ease. It is said that Sind merchants used to travel South in the winter, selling their goods along the way, and that they returned in the summer with the winds from the South. In this way they used the natural force of wind on both legs of their journey, which turned out to be a very economical way to travel.

"The commercial magnates of Sind were very well conversant with the varied aspects of their enterprise. In the time of Shah Abdul Latif of Bhit (1689-1752), the steamboat had not yet been introduced as a carrier of Commerce. The merchants had to resort to what is commonly denominated "Native Craft", which boasted a great variety of boats of varying sizes and shapes, big and small, coasting and oceanic, "*Doondees*", "*Kotias*", Ships etc. were all found handy for commercial purposes. But all of them depended for their movements on the prevalent winds. ... in his Surs Samoondi and Sri Rag, and his poetry therefore affords an excellent picture of the Commerce of Sind during his time."

"With blowing of north-wind, a sadness burdens my heart,

For my merchant-prince is re-oiling his boat, and preparing for a voyage." (ibid.: 68)

"When the merchantmen picked up their anchor and ropes,

And spread their sails,  
The port and bazar seemed evacuated of all life and activity." (ibid.: 69)

## The Decline of the Mohannas' Economic Resources

Sailing and fishing used to form the major part of their livelihood, but both these sources have declined over the past years. There are a number of reasons for this, some of the main ones being listed below.

- i) The destruction of major commercial towns near the Indus by foreign invaders.
- ii) The use of steamboats on the Indus in the British Period (1843-1947).
- iii) The construction of railways and metalled roads. This shifted commerce away from towns lying on or near the Indus to other towns further away, situated near modern railways and roads. Because of these modern facilities, the transportation of goods became quicker and cheaper.
- iv) Modern industrialization reduced the demand for handicrafts in the towns and villages near the Indus.
- v) The construction of new dams on the Indus. The dams at Sukkur and Kotri isolated the Mohannas on the eastern Nara and lake Manchar from those living on the Indus.
- vi) The migration of local Sindhi Hindu merchants to India in 1947.
- vii) The closing of the rivers Sutley and Bias in the Punjab by India in 1970. The area surrounding these two rivers is irrigated by canals running from the Indus.
- viii) The construction of the large dams at Turbella and Mangla on the Indus.
- ix) Open auction of fishing leases. Rich landlords control the bidding at auctions and thus gain a monopoly. They then re-sell the leases to the highest bidder from the Mohannas.

For these reasons, many Mohannas can no longer exist from their traditional occupations of fishing and sailing, and are forced to migrate to land work and to join the peasant classes.

### The Mohanna Village

A Mohanna village consists of 15-20 highly decorated houseboats and a number of smaller ones used for fishing and as ferries by individual families. All these boats lie in a straight line north-south near the river bank, and form one village. The boats are secured by ropes tied to wooden stakes driven into the ground, and some boats also make use of heavy stones for anchors. There are two good reasons why the boats are aligned along this north-south axis; first, this is the direction in which the river flows, and secondly, the prevailing winds, in summer from the south and in winter from the north, cannot move their boats from their moorings. The open ground near the boats is used equally by each family for the construction of temporary huts in which they live while repairing and re-oiling their boats. These huts are built from wooden poles and beams, and are covered with rice straw or reeds.

Another small hut is built near to this which is used as a workshop for net making, straw mat weaving and basket making. This second hut is constructed in the same way as the main hut. It is also used as a storeroom for completed handicrafts, firewood and other raw materials, which are kept on the roof, leaving the shady interior free as a workshop.

Washing places are also to be found near to the boats. One narrow-mouthed straw basket full of fish is kept in the water near their boats. This supply of fresh fish is then either sold, or used by the families themselves.

The Mohanna house boat provides all the facilities needed by the family, there is space for working, sleeping, cooking, storage and even a toilet in one corner, with its outlet in the river. Drinking water is provided by the Indus, admittedly a few metres away from the boats. Birds and chickens are also bred on their boats, and when they are anchored near to the banks these fowl are allowed to run free on the open ground near the village.

The Mohannas also keep dogs, mainly to guard their villages. The ferry is situated approx. 500 m away from their village, and 500 further north they set out decoy birds as a trap to catch others.

Migrating Mohannas from another state are not allowed to anchor their boats near another village. Either they look for a spot far away from another village, or they will anchor on the other side of the river.

Villages are not permanent, but move according to the rise and fall of the level of the Indus and the ground conditions near the banks. When the water level starts to sink in September, the land left dry is usually rather different to the previous bank. Thus they migrate up or down the river, looking for flat ground, but never more than one kilometer away from their original position. This is because routes from surrounding villages lead to their ferries, and this being a large part of their income, they cannot afford to lose custom by moving too far away. During extreme floods on the Indus River, they build temporary reed huts on safe ground to stay out of danger.

### Inter-Village Relationships

The Mohanna maintain socio-economic relations with nearby villages. In the social context they are invited by the village peasantry to their marriage ceremonies and other festivals, whereby they pay an offering to the host, and bear the expenses of any rite such as circumcision as well as the wedding ceremony. They also celebrate the festivals of "*Mailla*" together with the

local peasantry. These "*Mailla*" are religious festivals to celebrate the anniversary of someone's death.

On an economic level the Mohanna have a clientele system with the peasants called "*Aahat*". In this system, the Mohanna provide a ferry service, in lieu of which the peasants give a fixed amount of grain at harvest time. Contracts are made between single families on both sides. Thus if one of the peasant families separates into two independent units, the new family will have to go to the Mohannas for a new contract as a separate family. Likewise when a Mohanna separates, the new family has to arrange new customers.

Most of the grain the Mohannas receive for their ferry services is kept for their own consumption. If, however, there is a surplus, the grain is sold in the nearest town or village for cash. Any extra fish is also sold in the larger towns. Any people without a fixed contract pay normally for the ferry services, and a small income is made through the sale of straw mats etc.. This money is then used to buy vegetables, butter, oil, meat from the nearby villages, and other necessities such as clothes, jewellery, medicine and material for repairing their boats, e. g. wood, iron etc. are bought in the larger towns.

### Social Organization

As has already been mentioned, the Mohanna caste can be divided into the "*Mirbahar*" and the "*Mallah*". People who leave their profession change their caste at the same time, e. g. "*Mirani*", "*Bahleem*", "*Jhaber*" etc.. In the caste are found "*para*" — which are named after their forefathers from between 12 and 20 generations ago. In one caste 3-4 "*para*" live together and form one village. 3-4 villages together form a sort of cluster organization.

Without this system social relations would break down and disputes could not be settled; the caste members would feel insecure.

Each village has its own social rules, based on the area where it is found and on the other hierarchic systems found in the surrounding villages. Minor differences also arise in rites and customs through differing religious beliefs, for example between the Shia Mohanna and the Suni Mohanna, which then appear as differences in the social organization. Through this social structure equal fishing rights are maintained, help is given at ceremonies, and disputes settled fairly.

The father is the head of the family, and one "*para*", or group of families, jointly elect one spokesman, usually an older man who has a better social status and more experience than others.

The heads of all the "*paras*" form one group in the village hierarchy. These then elect one delegate for the whole village, who is in a socially higher position than anyone else.

The chiefs of the villages elect one member as the chief of the whole caste of the boatmen — fishermen and sailors.

There are two ways of settling a dispute in a Mohanna village. In the first method, both parties involved select an equal number of arbitrators and one head as a judge. The affair is discussed before the whole village, with each member giving his opinion in support of or against one party or the other. After this open discussion, the arbitrators and the judge confer together to decide on the outcome. A majority decision must be reached, if the arbitrators are split equally then the judge has the deciding vote. This solution is called "*Aminanjo Faislo*".

The second system of settling disputes operates along the same lines as the first. It is usually used in disputes with other local castes, and in this system the leader of the caste has the superior position, the heads of the villages have a secondary one and the villagers themselves the lowest position in decision making.

In the Mohanna social structure the men have a dominant position over the woman. According to their marriage system, there can be no marriage with people from different religious groups or castes nor with Mohannas from other states e. g. the Punjab ("*Pardaisi*"). Although they could be neighbours, performing their own customs and with their own traditions, no relationship is formed between the two communities.

### Subsistence

The staple diet of the Mohannas is fish, rice or rice bread. The fish are caught in the Indus, and rice is given by clients as a form of toll for the ferry services. Although rice is the major grain crop in this area, some peasants also cultivate wheat, thus wheat bread can sometimes be found in the Mohanna's diet. Meat, vegetables, ghee, tea and sugar are bought from the markets in the nearby villages, although most of the Mohanna are so poor that such goods are almost a luxury. Fresh fruit and milk are not included in their diet.

As has been mentioned, drinking water is taken directly from the Indus. Because of this impure water and the poor nutritional conditions, the majority of adults and children are plagued by infectious diseases in the winter; colds and coughs spread rapidly throughout the whole community. In the summer, mosquitos are abundant, breeding readily in the mud and stagnant

waters, and because of this malaria and fever are frequent hazards for the Mohannas.

## Shelter

The house boats of the Mohannas are called "*Doondees*". One family may live in the same small boat for as long as half a century. These "*Doondees*" range in size between 6 m long and 2 m wide up to a length of 14 m and a width of 4 m in the middle of the boat. The boat is basically steered by a gibstaff. In deeper waters, the Mohannas employ a very simple steering oar made from a wooden pole supporting a small wooden plank. The two elements are connected together by a leather rope. The steering oar is operated in the stern section. The boats are fitted with a mast erected in the prow section. Finally, the boat is controlled by a wooden rudder.

The boat can be subdivided into three parts: prow, cabin and stern. Traditionally the prow provides the cooking area on the house boat. In this part of the boat are kept the grinding mill stone and the unbaked clay ovens. The cabin, covered with straw mats, is used as a living and sleeping area. The stern, where the rudder and steering oar are fixed, seems to be left for controlling the boat. Under both prow and stern are two large cavities utilized as storage space. In the stern are also fixed the pennon-like strips. The Mohannas could not explain their function, but simply said they served as decoration. In the stern section can also be found the ensign poles. These ensigns, besides being used as decoration, also seem to indicate wind direction.

A small house boat can accommodate a maximum of 6 family members, whereas one of the larger boats has room for up to 15 people.

## Different Types of Boat

The Mohanna have several types of boat. The "*Doondee*", as well as being a house boat, is also used for fishing. The "*Nau*", with the cabin in the stern, is used as a ferry; the central open space being left for loading and unloading goods and people.

The person sailing this type of boat is called "*Naukho*". "*Patelo*" or "*Batelo*" is a small boat without rudder or cabin. Easy to row, it is used for fishing and transport. A total of more than 12 types of boat are used by the

Mohannas of Sind. The Mohannas in the village in question made use of only the three types described above. Other forms are used on the lakes and open sea. The price of a small boat is about 4 000 rs., while the larger ones may cost anything up to 36 000 rs.. Usually the families living in the smaller boats cannot afford such sums of money. The Mohannas living in the larger boats mostly have contract for the ferry, and earn more than the simple fishermen.

## Construction of a Mohanna Boat

The boats used by the Mohanna throughout the centuries are a central element in their daily life; they represent at the same time a house and the basic unit of production. The boats are constructed by Mohanna carpenters from mast tree wood, which is both light and strong. The trees are felled in the forests to the north, and transported downstream from the Sukkur dam.

The first stage in the construction of a boat is the formation of the sides, strengthened by rib-like pegs. In the second stage, the bottom of the boat is formed, broad in the middle section and narrowing symmetrically at both ends. The ends are also bent upwards, this being achieved by moistening the wood beforehand. Similarly to the side pieces, the bottom of the boat is strengthened by nailing a series of lateral ribs to the floor. The sides are then fixed onto the base. The prow and stern are then covered with planks, supported by further wooden ribs. Except for the use of a few large nails, the whole construction is held together by bamboo dowels. These expand in water and give an overall stability to the construction. Metal nails are rather impractical because of the problem of rusting. The next step is the construction of the central cabin. This is formed by a rectangular frame covered by planks, or sometimes simply wooden sticks, and supported by 4 poles. Poles and ceiling are joined by a simple dowel and socket system. Finally the carpenters add the rudder, the pennon-like strips for ensigns and the steering oar. On the larger ferries and house boats an additional cabin is sometimes constructed.

The Mohanna carpenters are skilful woodcarvers. Every part of the boat is carved by hammer and chisel with elegant motifs in the form of floral designs, or sketches of birds or fish. Each artisan has his own repertory of motifs; unfortunately no copies could be reproduced for publication. Pre designs of pre models are not prepared by Mohannas.

The same amount of skill is clearly shown by the system of measurement and boat planning they use. As a unit of measurement they use the width of one

finger; 12 fingers form one hand (the width of the hand is calculated from the tip of the thumb to the tip of the little finger); 2 hands are equivalent to one arm unit, and 2 arms are equal to one yard. Similarly, the planks are cut with angles which are simply memorized. Straight lines are drawn with a thread dipped in charcoal water colour. This technological simplicity is reflected also in the very restricted inventory of tools needed for boat construction: the saw, the adze, the chisel, the hammer, the drill and the carpenter's plane, plus the above-mentioned thread for the straight lines.

### The Boat Inauguration Ceremony

The Mohanna fishermen and sailors living on their house boats have one tradition that has been handed down from their forefathers. It seems they believe in omens, a remnant of Brahmani bibliomancy. They are muslim, and mix this belief with old traditions and customs in their everyday life.

The carpenter has to inform the owner one week before the completion of the boat. This gives him time to invite all the relatives, neighbouring Mohannas and the local people living near to the village who are allowed to participate in their celebrations.

The owner also invites musicians and a "*Mullan*" to pray on the day inauguration. He then has to buy rice and other food and very likely borrow cooking pots. The owner's family then meets together to decide upon a good day and date for the inauguration. They prefer even numbers ("*Bhadi*") to odd ones ("*Eki*") because even numbers are thought of as numbers of unity, and odd ones of disunity. Also Saturday ("*Chhanchhar*") and Tuesday ("*Aangaro*") are considered to be bad luck days. This is because "*Chhanchhari*", which means a Brahman who averts the influence of the planet Saturn, belongs to Saturday, and Tuesday is said to be unlucky in bibliomancy books.

The celebrations on the day start before noon, when all the participants have finished their work. Tents and reed huts are erected for the men near to the new boat, and more tents and huts are erected about 100 m further away for the women. The musicians play romantic, traditional folksongs, but only for the men. The women sing for themselves. The food is then served. A barber can be found in the men's tents cutting hair. He is paid by all present.

In the afternoon the Mohannas start to decorate the boat. They fix ensigns made of decorated coloured cloth onto the stern of the boat. The carpenter then makes a last check, and when he is satisfied he fixes the "anchor poles" on the prow. His work is then completed. All the participants then lay down tamarisk sticks in a line from the boat to the river. Water is

then sprinkled over these to ease the transport of the boat. Strong jute ropes are then tied to the anchor poles on the prow.

The carpenter is then called and given a new set of clothes consisting of turban, shirt and trousers. This is the traditional gift given by the owner.

Then the owner or a member of his family scatters grains of wheat and rice over the boat. This is an omen in Brahmani bibliomancy which is said to ensure a large income, abundance of grain and food and a peaceful life for the family as long as they live on the boat.

The "*Mullan*" is then called onto the boat, and all the people raise their hands in prayer. The "*Mullan*" has memorized the whole of the Koran, and he now recites some of the verses from the Koran, e. g. "God may protect them from disasters, make them rich . . .".

After the prayers everyone has to pay between 5 and 50 rupees to the owner of the boat. This is the same at each ceremony. Then the participants divide into two groups and begin to pull the boat from both sides into the water, with much singing and chanting to keep time. At first the boat is pulled in a zig-zag to get it moving, and once in motion on the tamarisk sticks it is pulled directly into the water. When the boat is finally in the water, everybody crowds on board and they all receive a small bag of sweets which have been kept especially for this occasion. The inauguration ceremony inevitably ends with happy scenes.

### Family System

Each Mohanna family consists of between 7 and 11 members. The birth of a son is thought of as a guarantee of help and support for the parents in old age. With a daughter it is said that she will go to serve another's house — "A daughter is like a transplant; where she is transplanted, then she will grow there for ever". The son, however, will stay together with the parents until he is married. In some families one son is duty bound to stay with his parents until another brother marries and his wife can serve the parents. After the death of the father, the sons receive equal portions of his property, and the daughters only receive the half of their brothers' share.

### Marriage Systems

The parents of the girl and boy arrange the engagement. In some cases the boy may be allowed to choose

himself, but a girl never has a choice. When a girl is 14 years old she is thought of as adult, and her parents look around for a partner. The Mohanna have the same marriage system as that of some tribes living in upper Sind. There are two systems to arrange a wife.

One way is the exchange of girls; one adult girl for another, or two younger ones for an adult, or a younger girl and a sum of money ("*Gurth*"). In some cases it is even arranged for one young girl and the next girl to be born either in the man's family or the adult girl's first baby daughter ("*Paitu*").

The second system is to sell the girl for money, anything between 10 000 and 25 000 rupees.

When the engagement has been settled by both families the betrothal ceremony is performed. All relatives and neighbours are invited by the boy's father to the girl's father's house. This gathering of people is called the meeting of the fraternity (Brotherhood) of "*Ghur Kheer*" (Gur and milk). The girl's father has to declare the engagement of his daughter by giving the man's name. The fraternity members (all the people living in the village) are witnesses.

If one of the parties breaks his or her promise, then they will be punished by the fraternity. After the engagement has been declared, the parents of the man distribute sweets among the guests. In a few cases the "*Mullan*" is called upon to declare the matrimony and set it down in writing ("*Nikah*"). But usually this religious rite is performed at the time of the actual wedding, in which a marriage position is settled by the husband upon the wife in cash or gold and silver jewelry. In case of divorce or death of the husband without children she can use it for expenditure which is called "*Hag Mahar*" in Sindhi.

### The Marriage Ceremony (*Shadi*)

When the girl is 14 years old the parents of the betrothed man come to the girl's parents to ask permission for a wedding date ("*Fix Teth*"). The date is then fixed, bearing in mind lucky days, months and dates (see section on inauguration ceremony).

5-7 days before the appointed date the "*Vanwah*" or "*Khumbo*" ceremony is performed. A procession of women pass from the bridegroom's house to the bride's. The parents of the bridegroom give about 4 kg of butter oil, sweets and bright red cloth, "*Khumba lata*", to the bride. During the "*Vanwah*" or "*Khumbo*" period the bride and groom are not allowed to leave their respective homes. The groom wears a red woollen string around his wrist, and one ornament of iron to ward off evil. Neither bride nor groom is allowed to eat curry because of the sour taste of chilly, nor can they eat things cooked on a fire. Fire and sour foods are not a

good omen for lifelong relations. The bride wears bright red clothes, and her mother rubs dry flour over her whole body to make it shine. This application of flour is called "*Aaton*". One day before the wedding *Lawsonialba Henna* ("*Mendee*") is applied to the hands and feet of the bride and groom in their own homes.

During "*Vanwah*" or "*Khumbo*", many rituals, mixtures of Muslim and Hindu, are performed to ensure a happy and loving life for the couple.

On the day of the wedding the groom reaches the home or village of the bride before sunrise, followed by a procession of men and woman in decorated boats. The women sing folksongs ("*Lada*" or "*Sehra*").

The groom has to take a bath there and put on new clothes and a new turban. Many rituals are performed by the bride and groom, mostly relating to the bride winning the groom. Religious perfumes are then applied to the bride and groom. After matrimony, the groom is called into the bride's boat for "*Lawan*". The sisters of the bride and groom then knock the bride's and groom's heads together seven times (Brahmanic Hindu marriage ceremony). The women then tie a band, ("*Morah*"), decorated with embroidery, mirrors and beads on the bride's forehead. They then tie the corners of their shawls together, "*Ajak*" and "*Poti*", this ritual being called "*Palva Badham*". Finally, a specially decorated boat carries the couple to the groom's house.

### Other Ceremonies

Circumcision ceremony. "*Tuhaar*".

This ceremony is variously celebrated. The poorer people only distribute sweets to their guests, while rich families arrange for food to be served and receive an offering "*Ghor*". Most children are circumcised before reaching puberty in the Mohammadan belief, and in any case before they marry.

"*Bas*"

This ceremony is celebrated near the grave of a Saint. Meat and rice are cooked as an offering when desires have been fulfilled by the saint, for example, on the occasion of a birth or marriage.

### Festivals

"*Maila*"

This festival takes place in three villages in Sind once a year. It is held on the anniversary of the death of a saint and lasts three days, usually centered around the saint's grave or tomb.

Musicians and singers come and play romantic folk-songs, travelling salesmen sell toys, sweets and handicrafts. Sindhi wrestling bouts take place alongside horse and camel races. During "Maila" the streets are decorated with coloured flowers, and all the villagers come in brightly coloured clothes to buy the cheap goods on offer.

The Mohanna go to the nearest "Maila" in either Baheriji, Mahmmud Shah or Dokri. Apart from these three "Mailas" there are three other large "Mailas" in Sind: at Shah Bittai near Hala, Lal Shabaz Qualander in Sehwan and Barea Sharif in Ranipur. Some Mohanna travel to these "Mailas" also.

Apart from the "Maila" celebrations, every village in Dokri Taluka arranges bullock cart racing. This is also a great source of entertainment for the Mohanna and the other villagers.

### Some Basic Aspects of Mohanna Economy

#### Fishing

As already stated, fishing is historically the basic activity of the Mohanna. The normal fishing season starts in February and lasts until June. In February, when the Indus becomes narrow and shallow, the Mohanna can cast their nets across the river, blocking its course completely. This extends along both sides for approx. 2 km.

The whole village gathers at this time to exploit this opportunity. Each house boat casts its nets, and the whole family helps in the work. It is very often the case that the woman row the boats while the men haul in the nets. These collective fishing activities are under the supervision of a Mohanna chief, who is there to see that each family has an equal chance. All families are bound to accept his decision. On the other hand the Mohanna collectively pay a contract fee to the Government for fishing and bird hunting. The fish are sold to fishmongers, who are also Mohannas. In turn, they sell the fish to the neighbouring towns and villages. In times of abundance, the product is distributed directly in the towns' fish markets. A certain amount of the catch is kept in narrow-mouthed baskets for their own consumption.

The fish usually bring about 10-12 rupees per kilo, and during the good season each family can count on approx. 8 kilos daily. When the collective fishing season ends, the nets are cast individually, and as a rule each family catches about 2 kilos per day, which is then used as food for themselves.

There are 7 kinds of fish caught in the Indus:

- 1) "Pallo" — the "Hilsar" of Bengal, so-called "sable-fish" (Clupeidae fam.)

- 2) "Gandan" — a knife fish (Notopteridae fam.)
- 3) "Khago" — a sheat-fish (Siluridae fam.)
- 4) "Morakhi" — a carp-fish (Cyprinidae fam.)
- 5) "Dambhro" — a carp-fish (Cyprinidae fam.)
- 6) "Singari" — a sheat-fish (Siluridae fam.)
- 7) "Poiki" — a sheat-fish (Siluridae fam.)

#### Bird hunting

Bird hunting is another important Mohanna activity. Migrant birds reach Sind in the winter season. The Mohanna employ for hunting at least a couple of decoy birds, which are tied to a stick in the water. The only device used by the Mohanna for catching the birds is a bird mask, which floats on the surface of the water as the swimming hunters approach.

The birds are then simply caught by hand from underwater. Unlike fishing, bird hunting appears to be forbidden for women. The captured animals are either sold inland or eaten directly by the hunter's family. The birds caught are migratory birds which come from the north in the winter season. Each bird is sold for approx. 15 rupees.

#### Craft activities

The technology used in producing the small handicraft items is very old and simple. The products are either used by the producers themselves or sold to the nearby villagers and contractors.

The raw materials for the straw mats and baskets are collected from the Indus. The men cut the tamarisk sticks and reeds from the river bank, and the elephant grass from small ponds near the river.

The tamarisk sticks are left out in the sun to dry for two days. Then are they kept for one day in water, and on the second day they are ready for use. The women can produce two mats in one day, which could be sold for 8 rupees each. A narrow-mouthed jar, costing 12 rupees can also be completed in one day, whereas a large straw vessel for grain costing 150 rupees takes 6 days. The mats made from elephant grass take two days and cost 25 rupees. The men occasionally make fishing nets and then sell them to other Mohannas, making a profit of around 20 rupees per day. It takes 3 days to make one small net.

#### Dress

The Mohannas wear the traditional dress of the Upper Sind region.

#### Male dress

"Pateko" — the turban

A loose thin cloth, 4-5 m long, made of cotton or silk tied around the head and worn by every adult. The

turban of honour or chief's turban is tied in a ceremony before all the members of the village on the selection of a new chief. When the father dies, the turban is passed on to the elder son, as the new head of the family, and is tied in the presence of relatives and members of the village in another ceremony. When two friends exchange their turbans it is said to be a sign of bosom friendship.

*"Kamees"* — the shirt

The old men of the Mohanna still wear the traditional *"Pahryan"*, a shirt without collar or cuffs. However, younger people wear modern shirts with collars and cuffs. These reach to the knees, and are made of various coloured cloths.

*"Shalwar"* — trousers

Wide and loose, containing 4 m of cloth, various colours.

*"Poterio"*

A loin cloth tied around the head.

*"Gode"*

The dhoti is fastened by crossing both ends at the front and tucking them in. While working in the village the men wear a *"Gode"*, but for ceremonies and for going into town the *"Shalwar"* is worn.

*"Ajrak"* — shawl

The famous traditional shawl, hand-printed with geometrie floral designs and eight cornered white stars. The designs are either dark red on a blue background, or vice versa, but the stars are always white. Sind is the only place in the world where these Ajrak are made. The theory has been put forward by several Sindhi scholars that the priest-king from Mohan-jo-Daro is wearing the same type of cloth with floral designs. Moulana G. M. Germani has written in an article: "When invaders were burning the libraries and books of Sind, Sindhi people printed this cloth with many secret hints".

Female dress

*"Poti"*

A block printed cloth of various colours, wrapped around the head and shoulders of women. It is thought to protect the woman's honour by hiding her face from strangers.

*"Burko"*

A veil covering the whole body down to the feet with eye holes. Women wear this when they leave their house boats, for example to visit parents or to go to town to buy medicine. According to Mohammadan law it is worn for privacy, i. e. so that strangers may not see any part of her body.

*"Cholo"*, or *"Kamees"*

A shirt worn by women, with block prints of a floral or geometrical design, decorated with embroidery around the neck, shoulders and arms.

*"Suthan"* — trousers

Made from the same material as the shirt. The lower edges of the trousers are decorated with embroidery.

*"Juttee"*

The leather chapal, traditionally with a woollen flower on the front.

## Language

The language spoken by the Mohanna is a dialect of the upper Sind region, actually a literary dialect of Sind. But the Mohanna have also preserved many words from the old vocabulary, present in the poetry of the classical poet of Sind, Shah Abdul Latif of Bhit (1689-1752). These old words have been forgotten by the present writers of Sind and are not spoken by people living on the land in the same area as the Mohanna, or at least not in the villages and towns where modernization has had an influence on society.

It is remarkable that the rural areas of Sind also preserve the old vocabulary. It could be because the small villages are somewhat isolated from the larger towns, have no access to modern literature and are very much self-sufficient.

## The Protohistoric Evidence

The trade relationship between the Indus Civilization, the centres of the Persian Gulf and the great towns of Mesopotamia have already been discussed and reported by several scholars, on the basis of the evidence discovered from the protohistorical sites of the above mentioned civilizations.

The most important body of data available to date is formed by the written documents unearthed in Mesopotamia, dated to the period between Sargon's conquest (2351 B. C.), and the so-called Isin-Larsa period (about 1800 B. C.). The tablets record movements of ships loaded with commodities coming from the faraway countries of Dilmun, Magan and Meluhha. It is generally assumed that this last political entity should be indentified as the complex of the Indus Civilization. The great West-East sea route was apparently open for at least 5 centuries; during this period, it complemented the inland trade routes in providing the Indus centres with all required commodities.

A centre like Mohan-jo-Daro, rising from the banks of *Sindhu Darya*, had to rely heavily on river facilities for transport services.

Notwithstanding the environmental constraints, we can imagine the Indus system as some kind of natural

highway supporting part of the enormous trading network which furnished the towns with products coming from a very wide and diversified range of countries and regions.

The representations of boats discovered at Mohan-jo-Daro could be considered, in this perspective, as a record of the "Chiefs of the Water", *Mirbahar* and *Mallah* who were known to the Harappan people. In comparing the boat represented in the seal reported by Mackay (1938: 30, Pl. LXXXIV) with the actual Mohanna boats we can observe that the protohistorical boat has a more strongly upturned prow, while they appear very similar in having a central cabin; the pennon-like strips which are represented on both sides of the cabin could be seen as analogous to the ones visible in the stern section of Mohanna boats. The steering oar on the seal boat representation would appear structurally identical to the modern specimens.

According to Mackay: "... this boat is shown as lashed together at both prow and stern indicating perhaps that it was made of reeds" (ibid.: 30). The oldest historical accounts of this topic indicate that in the 8th century B. C. Sindhi people were constructing their boats from coconut planks connected by ropes (Tareek Tamdan Sind: 193). The pottery sherd with graffiti (Mackay, 1938: Pl. LXIX, 14) represents a boat with sharply upturned prow and stern, apparently controlled by a single oar. The boat seems to be provided with a rudder, and a system of vertical and horizontal lines in the centre probably indicate a furled sail. A third boat representation from Mohan-jo-Daro provides us with further information. Stern and prow, as in the former representations, appear upturned. The central cabin is endowed with the pennon-like strips we have encountered in the first case, again placed on both sides. In correspondence with the stern, one line suggests the presence of the steering oar, while the second could represent the rudder. Two birds are arranged symmetrically on the boat, making us think of the present-day Mohanna practice of keeping at least a couple of birds on each house boat.

On the whole, the available evidence, although very scanty, would seem to indicate a series of morphological and technological convergences between the protohistorical boats and the Mohanna ones.

Given the central role of the seals and sealing devices within administration systems, we could infer that the role of the protohistorical "Chiefs of the Water" in the transport services and, more generally, in the economy of the town was a very substantial one.

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Fig. 1

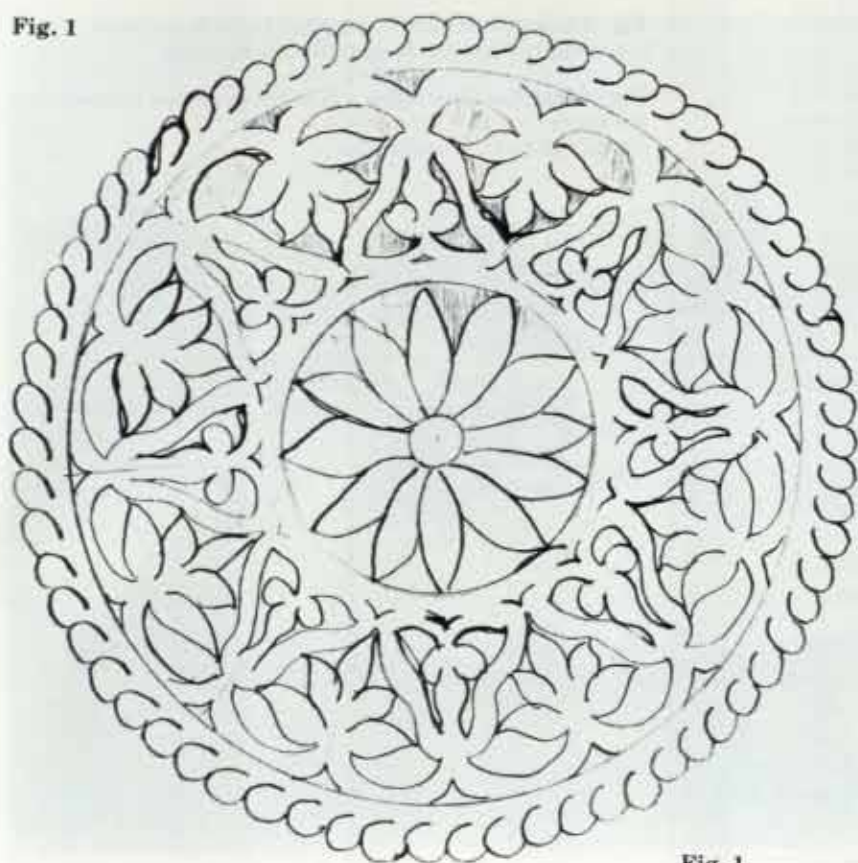


Fig. 1 Wood-carving ornaments.  
(Drawings by Ghulam Ali Mohano).

Fig. 1

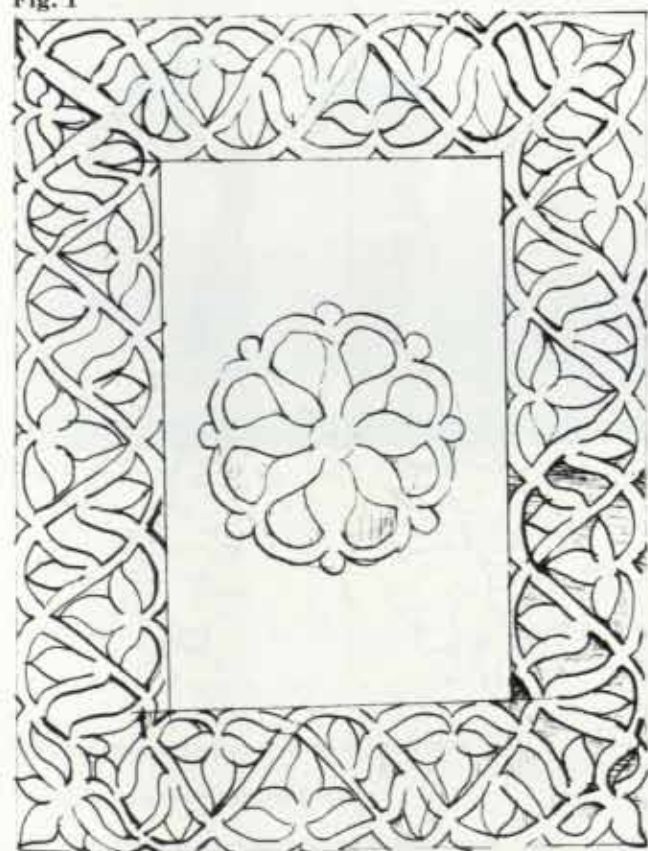


Fig. 1

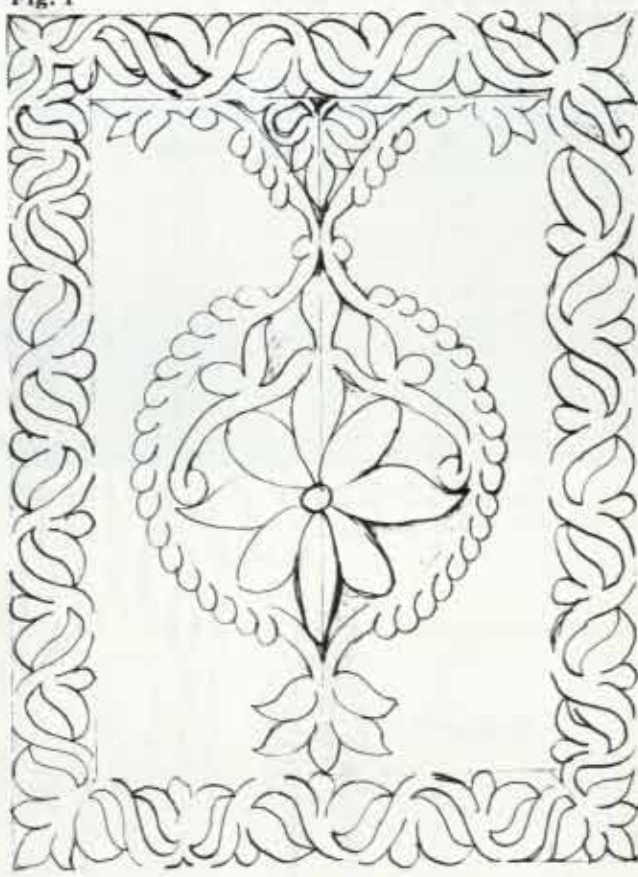


Fig. 2

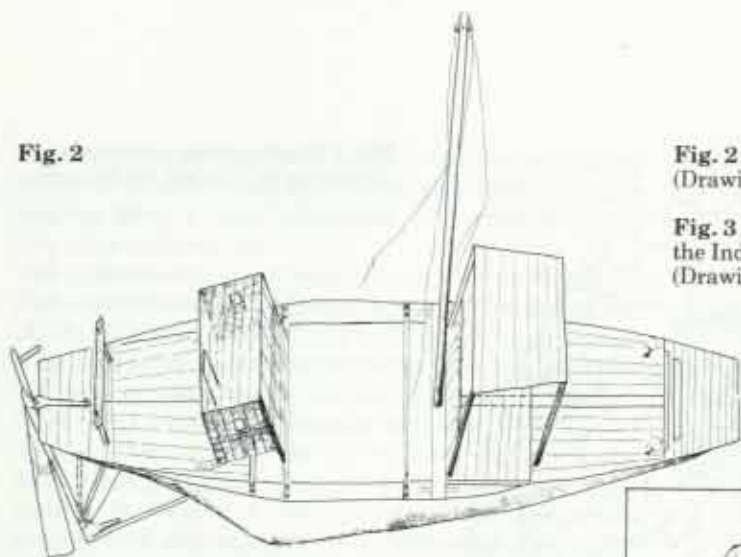


Fig. 2 Isometrical view of a typical Indus house boat.  
(Drawing by Susanne Walter after G. M. Shar).

Fig. 3 Sketches illustrating a boat inauguration ceremony on the Indus.  
(Drawings by G. Mustafa Shar).

Fig. 3

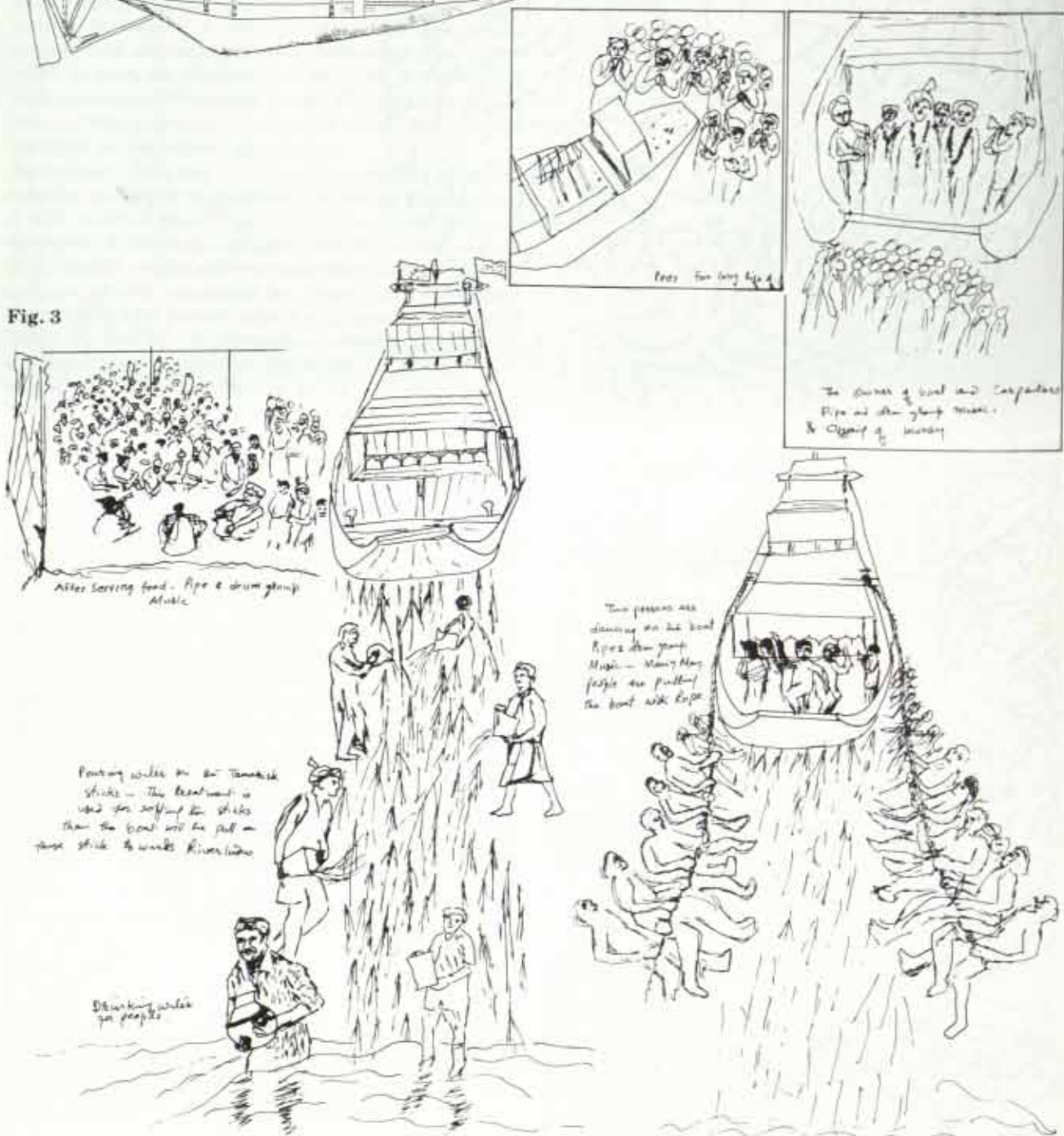




Fig. 4



Fig. 5



Fig. 6

Fig. 4 A Mohanna house boat on the Indus.

Fig. 5 Ferries crossing the Indus.

Fig. 6 A Mohanna village on the Indus.



## Boats on the Indus

Salma Sultana Begum  
Custodian Archaeological Museum  
Mohenjo-Daro

On February 6th 1982 I visited an island in the Indus river together with some members of the team of Dr. Michael Jansen from the Research Project Mohenjo-Daro. There were many boats and the fishermen, the owners of the boats, were standing beside them. Together with Alexandra Jansen I asked for permission to enter the boat of Mr. Mohammad Usman. He told us the name of the boat was "*Beri*" in Sindhi language.

A whole family lives on such a boat and the cabin (called "*Tarro*") is used for sleeping at night but also for sewing and other domestic work during the day. When a child is born, this also takes place in the inner chamber, without a lady doctor's help, but only that of the old women of the community.

All the men, women and children of the family live on the same boat. Even a baby's cradle called "*Pingho*" will be hung from the ceiling. The left side of this section is reserved for storage of food, such as grain, sugar and rice, and a clay oven to cook on, thus it functions as a kitchen. The upper part of this section is called "*Khattaro*" likewise the corresponding part on the right-hand side, but here the family keeps its personal belongings.

The most interesting part is the cabin floor, the "*Tarro*", which is covered with embroidered pillows and hand-made bed sheets of multi-coloured cotton quilts, in such a way that the place gives the impression of a drawing-room.

I asked Mohammad Usman's wife, Rahmat Jan, about her hobbies. She uses her leisure time for weaving mats that they put on top of the roof as a shelter against sun and rain. She also makes the cotton quilts, called "*Rilli*", caps with embroidery and glasswork, called "*Balochi Topi Sindhi*", covers for cushions and table cloths ("*Sagi*"), vests called "*Ganji*", fans ("*Vijno*"), traditional dresses ("*Shalwar qamiz*") and "*Gaji*", the embroidered collars for shirts.

The men in turn are concerned with producing the following articles:

1. "*Sindhi juti*" (Chappal)
2. "*Yaktara*" (musical instrument)
3. Bullock cart
4. "*Pingho*" (cradle)
5. "*Khaat*" (Charpoi)
6. "*Sindhi ajrak*" (shawl)

Asking about how they finance the raw material for these products I was told by one fisherman, Mr. Ghulam Rasool, that the contractors for whom they work provide the material and pay a charge for each article produced by the fisherman's family.

Except for the mats, everything is produced inside the cabin. I asked Mr. Usman's sister, Sahib Khatoon, how the marriage ceremony takes place in such a small cabin. She answered that on such occasions they borrowed any available boat from neighbours and relatives. The women guests will sit in the "*Tarro*" and the men outside on the bow ("*Aggal Takhto*") or the stern ("*Pachal Takhto*"), "*Takhto*" meaning board. I wanted to find out from Mr. Usman whether all the fishermen were relatives. The answer was that they are neighbours, but they all have the same name "*Maachi*", which means "men who catch fish".

The interior of the boat is decorated with woodcarving, which is called "Chitr" and the different floral designs have various names.

Normally the front outer section of the boat is called "Aggal Takhto" and it is an empty space to keep their articles for sale. The stern "Pachal Takhto" is decorated with multicoloured flags called "Add", "Qalmi", and "Seer". Here they also keep their pet birds. The upper roof is called "Majjo". It is a sitting area and the family also sleeps there in summer. It is decorated with the "Rilli" bed sheets and pillows. The whole area is covered with mats as a shelter ("Pakkho") to protect the boat from heat and rain. "Mir Bahar" is the sailor, "Wange" the rope and "Bhilli" the anchor.

As was already mentioned, the main source of income is fishing. From 1982 on the fishermen started to send their goods to Quetta, which hopefully improved their earnings considerably. Furthermore they take tourists for a boat trip on the river whom they charge with thirty to forty rupees. Local people like businessmen from Kandyaro or Nawabshah, who have to cross the river daily, are not charged. They pay with natural goods such as, for example, grain. They take their grain bags, goats, cows, bulls and even camels with them. For each camel they are charged with forty rupees.

At times of high water level in June/July the boats have to take a longer distance to cross the river; then the charge amounts to ten rupees per head, except for children, whereas in the rest of the year the charge is five rupees.

If it becomes too dangerous for the fishermen to live on their boats they move to Kandyaro, Nawabshah, Balharji or Hassan Wahan where they build temporary huts from wood and the above mentioned mats. But they continue to go fishing.

#### Boat Inauguration Ceremony on 13<sup>th</sup> of May, 1982

When we reached the river banks there were already hundreds of people who gathered round the musicians and folksong singers. In a hut or tent made of reed and decorated cloth we recorded only small parts of each song as only one single tape was available. But important moments like during the pulling of the boat were recorded entirely. The different songs are recognizable by their changing sound. The texts run as follows:

1. "Qabar meen Kursi hundi Moula Amir ji". It is a religious song and means "I will be the chair of Hazrat Ali in the grave, Hazrat Ali will help and save in the grave".

2. "Dil ji dil Khay Khabar — Qurib kayo hui piara Qurb Kayo huyoi dost: Tuheñja thora na Lahyan" is a romantic song.

3. "Warandy neer Hazaran — Haklan Maran. Taidy karan yar piara Tady Karan Dost" means: "Tears are coming out for you, my friend".

4. "Tuñ Samo, helly auñ ghandhery muñ meen aiban Lākh", means: "You are Samo (i. e. a superior Mohanna caste), I am a fisher and in me are a hundred thousand faults." It is the song of Muri, the fishermaid who became Jam Tamachi's queen.

5. "Kadhee chad Arman Andar maun — Matan Mohammad Wajay Waree", is a song about a myth, when Iman Hussain awoke two dead sons of a pagan lady with the miracle of Muhammad. She converted and became Muslim. The text means: "Leave sorrows from your heart, may not Mohammad go back".

6. "Bairi Lah, Lagae wa'o gajka ludan tha" means: "Pull and keep your boat in the river, with wind the flags of boat should wave". This song is about boats, it is a prayer for boats and contains the names of Pirs and Murshids and joking sentences.

Then the ceremonies for the boat inauguration start, people are talking and the drum group prepares its performance. We recorded more songs:

7. "Jamalo", a humorous song with jokes.

8. "Dil Bichit satay Yar Tairy milny noon" is a piece of music for flutes and drums.

After praying there follows another piece for flutes and drums and the blessing of the boat. Then a turban is tied around the carpenter's head and the owner has many currency necklaces. All the guests are in a very happy mood. The pipe and drum music stops while they give money to the owner of the boat: "Panj Rupy Sultan", Sultan gave five rupees.

After this financial contribution suddenly the music stopped again. There was a big bird in the waters of the Indus and one Mohanna went and shot it with a gun. Later the owner, the carpenter and two dancers are on the boat. The music has a magical influence on the people, they are shouting: "Pull, pull again!" Sometimes they are repeating sequences of the song "Ya Ali". Two groups are pulling the boat, each of them about forty to fifty people. They compete with each other. Each group is pulling on a thick rope which is attached to the boat. Sindhi dance and flute and drum music creates a certain spirit. When the boat is near to the water of the river Indus everybody is alert because of a game: There are about five kilo sweets on the boat and the one who first enters it as soon as it is in the water will win the prize. One of them was quicker than the others and had entered the boat secretly from the side. So he wins and gets all the sweets.



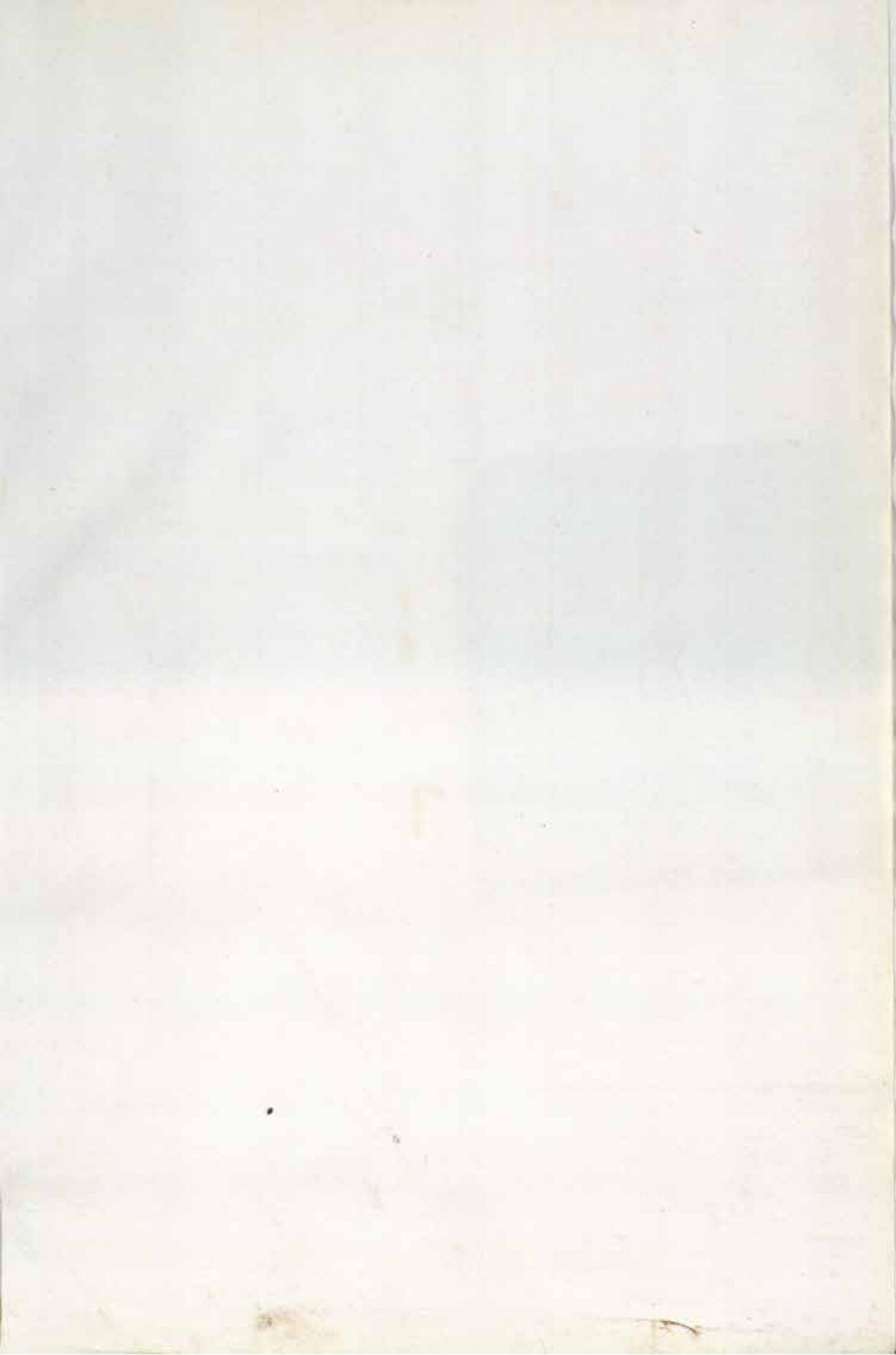
Fig. 1 Mohanna boat on the Indus.

Fig. 2 Mohanna fisherman.



महेंजोदरो,

Excavation — Mohenjo daro  
Mohenjo daro — Excavation





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*Paul*

# **Interim Reports**

## **Vol. 2**



Reports on Field Work  
Carried out at Mohenjo-Daro

# INTERIM REPORTS Vol. 2

Pakistan 1983-84  
by the IsMEO-  
Aachen-University Mission

edited by  
M. Jansen and G. Urban

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GERMAN RESEARCH PROJECT MOHENJO-DARO  
RWTH AACHEN

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ROMA

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Frontispiece: The IsMEO-Aachen-University Mission in  
Mohenjo-Daro 1984. (Photo: Georg Helmes, Aachen)

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### Concerning the contradictory spellings of the name "Mohenjo-Daro"

For this publication, the editors decided not to standardize the spelling of the name "*Mohenjo-Daro*", but rather to accept the different versions submitted by the authors. We therefore apologise for what at first sight appears to be an unsystematic way of writing. While the German Research Project uses the traditional form of "*Mohenjo-Daro*"; as can be found in Marshall, Mackay and Wheeler, other contributors favour a different spelling, such as "*Moenjodaro*", "*Moenjo Daro*" etc.. According to our Pakistani archaeologist, G.M. Shar, the meanings of the different spellings are as follows (Source: *Sindhi-English Dictionary, Second Edition, 1976*): Daro(daro) — دَرو — noun, in all cases meaning a heap or mound. Mohenjo — مهنجو — or Mohonjo — موهنجو — possessive pronoun, mine or my. Moen/Moan — موئن — past participle plural of to die, dead. jo — جو — preposition, of, mark of the possessive case. Mohan — موئن — noun, also Hindu name meaning one who fascinates. Epithet of Krishna. We thus have such possibilities as "My mound" or "The mound of the Dead" or "The mound of Mohan". According to the Sind Dictionary, the *Moen-jo-daro* form, with its variations of "*Moenjodaro*" or "*Moenjo Daro*", seems to be the most appropriate.

We feel it is necessary that one generally accepted spelling be adopted and used by all scholars in future works.

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## Preface

With the publication of Interim Reports 2 we present, slightly later than scheduled, contributions relating to the research period 1983-84 at Mohenjo-Daro, the sixth season of the RWTH Aachen Research Project Mohenjo-Daro and the second season of the joint IsMEO Rome/RWTH Aachen Mohenjo-Daro Project.

After two years' participation of Italian colleagues in the RWTH Aachen project at Mohenjo-Daro, a formal protocol of collaboration between IsMEO, Rome and RWTH Aachen was signed on December 14th 1983 in Rome for the duration of two years by Prof. Gherardo Gnoli, President IsMEO, Rome, and Prof. Günter Urban, then Vice Chancellor of RWTH Aachen.

In the meantime this protocol is about to be prolonged for the second two-year period.

On March 5th 1983 a corresponding licence had been issued by the Government of Pakistan for a period of three years allowing Aachen University and IsMEO, Rome to pursue a joint archaeological mission, commencing on January 1st 1983.

According to the application and the licence granted thereafter, the joint venture was oriented more to the development of a research strategy appropriate to the complexity of Mohenjo-Daro than to the mere gathering of further data.

Based on the maps and aerial photographs prepared by the RWTH Aachen Mission during the previous years, non-destructive methods, as had already been developed and tested by the Italian mission e.g. in Shahr-i Sokhta, were therefore developed.

Accordingly, the fieldwork had to be organized along three main lines of investigation: 1. surface evaluation of undisturbed surfaces of the site for craft activity; 2. geophysical prospections of the underground setting; 3. geo-environmental analyses of the site and its immediate surroundings.

The intensive activity of the many specialists involved in this programme allows a systematic evolution of many different methods, forwarding trends for successful collaboration.

Following the original intention, the IsMEO/RWTH project provided new research perspectives adjusted to the particular state of Mohenjo-Daro as a restricted archaeological site.

Its surface and subsurface can be studied in many different ways, still involving large bodies of data, by restricting observations to a limited area or class of materials, with the highly analytical capacity of a computer-based unit for recording and evaluation available in the field lab. The kind of object to be investigated, the field of observation and the means of employment have to be selected carefully before the ground surface is touched at all. Once on the ground, the most detailed recording scale has to be chosen in order to define the context with the largest possible supply of coherent data, whereby a higher level of awareness prevents one from any arbitrary selection. Besides the surface evaluation programme (SEP) the "forma urbis" research has become more and more important.

The study of the excavated remains, and especially the reports on the deep diggings, have been the primary sources for the analysis the vertical extent of the site up to the present. Drilling profiles and geophysical investigations carried out within the IsMEO/RWTH project have contributed to a better understanding.

In general, the research results have shown that there is a strong interdependency among the different approach strategies, which represent an optimized net of coordinated results.

There is no doubt that, once the strategies have been finally worked out, the computer-promoted treatment of collected data will show adequate results, as can already be recognized by first analyses.

The joint working phase began on February 1st 1984 and ended on March 15th 1984.

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As guests we could welcome Prof. Dr. George and Barbara Dales, Berkeley, Prof. Carl and Martha Lamberg-Karlovsky, Harvard, Dr. Jean-François and Catherine Jarrige, French Mission to Pakistan.

We are thankful to:

- the Director General, Department of Archaeology and Museums, Karachi, M. Ishtiaq Khan, and the Director Administration, Sh. Kurshid Hasan;
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RWTH Aachen Mission

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## Preliminary Results on the "forma urbis" Research at Mohenjo-Daro

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1931 (Marshall 1931). This plan is basically a topographic map, as is the "Wanzke-plan", prepared in 1979 for the ARPM and which is for the time being the reference map for all other studies.

Based on the Piggott-plan a hypothetical reconstruction of the site was later carried out which showed the citadel as part of a grid-iron patterned "roman castrum" with a squarish groundplan of approx. 1028 by 1211 meters.

Interestingly enough there are reports on structural remains outside the daros (Marshall 1931: 9) from the very beginnings of excavations at Mohenjo-Daro.

Recent reports by farmers from nearby villages indicated the presence of brick structures 3-4 meters below the surface which had been uncovered during the construction of wells.<sup>1</sup>

In 1981-82 M. Cucarzi was invited by the ARPM to carry out geophysical tests to trace underground structures, a program which in 1983 became part of the ARPM Aachen/IsMEO Rome project. A southern limitation of the inhabited site already discussed and anticipated in 1981-82 seemed to be proved by an approx. 400 m long geophysical anomaly which was interpreted by Cucarzi as "part of a mud-brick platform" (Cucarzi 1984: 195).

The "platform thinking" is nothing new for Mohenjo-Daro. On the contrary, it was intensively discussed in the sixties stimulated by Raikes' "flood theory". According to this theory the inhabitants of Mohenjo-Daro had started to construct platforms in the later urban period as an emergency programme against the rising flood waters of the Indus which, according to this theory, had been dammed through tectonic movements near Sehwan and which caused Mohenjo-Daro to slowly submerge.<sup>2</sup>

Under these circumstances the platforms would only have been a secondary appearance as a counteraction to floods endangering the settlement.

In a logical continuation of its documentation project on the excavated remains at Mohenjo-Daro which began in 1979, the "Aachen Research Project Mohenjo-Daro" (ARPM), RWTH Aachen, began in 1983 with observations for the study of the "forma urbis" of Mohenjo-Daro, the first results of which were published from 1985 onwards (Jansen 1984b, 1986b, 1987a, 1987c).

It was primarily stimulated by the still unpublished drawings and records of Wheeler's deep digging in 1950 west of the "granary", furthermore by the observations made between 1979-1982 during the construction of the collector-drain around Mohenjo-Daro (Save Mohenjo-Daro Project), where in several areas outside the anticipated city walls archaeological remains were cut, by several attempts which were made to reach virgin soil (deep diggings 1927-32, deep digging by Wheeler 1950, deep digging 1965 by Dales) and finally by Raikes' flood theory (1965).

In the light of these observations major questions remained to be answered: that of the horizontal-vertical extent of the architectural remains below the alluvial surface, that of the limits of the urban nucleus and existence of extraurban settlements (suburbs) etc. .

Since virgin soil was never reached through vertical diggings the full horizontal extent of the site beyond the mounds visible at present, which were normally regarded as being the outer limits of the former site, remains unknown.

Only one plan (Piggott 1950: 165), later adopted by Wheeler (1968: 36), indicated an area of the total site larger than that shown in the site plan published in

**The plain, the city and the floods: speculations and calculations.**

Floods as a reason for the abandonment or destruction of settlements form one known branch of the

"catastrophe theories" which were applied in the late 19th and early 20th century in order to explain phenomena of destruction or decline and which had their roots in the biblical "Deluge".<sup>3</sup>

Floods which might have endangered Mohenjo-Daro were first mentioned in Marshall's monography (Marshall 1931: 6) and related directly to its history and stratigraphy (ibid.: 102).

Seven years later Ernest Mackay hesitated to draw conclusions from the flood deposits at Ur (Mackay 1938: 5), but he recognized two floods within the stratigraphic context as being the reason for the repeated abandonment of the site.

In total, observations pro and contra the flood discussion can be differentiated into two categories:

1. those made outside the urban structures,
2. those made within the stratigraphic context of the urban structures.

Ad 1. It is extremely important to observe that morphological conditions around Mohenjo-Daro have changed during the last 4000 years. One fact has to be accepted: the ancient surrounding is buried under the sediments of the river, presumably for at least 7 meters (Jansen, this article) or 15 meters (Cucarzi, this publication). In general, scientists today agree that a process of silting-up has taken place during the last 4000 years at Mohenjo-Daro. Robert Raikes anticipated that this process took place in a very short period (Raikes 1965) while we anticipate a very long, more or less regular process.

In any case, destruction by floods in the upper parts of the city could only have taken place if the floods had reached these areas.

**Table 1**

*Stratification<sup>4</sup> of Mohenjo-Daro after Mackay 1938: XIV.XV based on a datum level of 178.9 ft (54.46 m) a.m.s.l. (DK-G area) with the hypothetical floods*

Late Period				
Phase	Ia	0-3.2 ft	-0.98 m	53.54 m
	Ib	av. 5 ft	-1.52 m	52.94 m
	II	av. 7 ft	-2.13 m	52.33 m
	III	av. 9.9 ft	-3.00 m	51.46 m
Intermediate Period				
Phase	I	av. 13 ft	-3.96 m	50.50 m
	II	av. 15.9 ft	-4.85 m	49.61 m
	III	av. 20.4 ft	-6.22 m	48.24 m
Early Period Plain of Today				
Phase	I	av. 24 ft	-7.32 m	47.14 m
	II			
	III			

Today, the plain around Mohenjo-Daro has a height of approx. 48 meter a.m.s.l., while the average of the lower city lies at approx. 52-53 meter and that of the citadel (great bath) at approx. 54-55 meter, with the highest areas around 59-60 meter.

4000 years ago the absolute height a.m.s.l. of the plain around Mohenjo-Daro were more or less the same as

today (approx. 48 m a.m.s.l.) a flood of approx. 3 meters height would have reached only the areas below the 51 meter isohyptic line of the site.

4000 years ago the plain had been much lower (approx. 41 meter a.m.s.l. as calculated by the author of this article or, according to Cucarzi, 33 m a.m.s.l. with a slow and more or less regular aggregation process<sup>5</sup>) even a gigantic flood rising more than 3 meters in the whole valley<sup>6</sup> would not even have reached the lowest levels (47 meter a.m.s.l.) excavated up to today in DK-G and termed by Marshall "Early I".

Even if we assume the ancient level was at 48 m a.m.s.l. (as it is today) the level of the anticipated "second flood" (52 m) would also have been above that even in the event of a very heavy flood.

None of the levels of the "floods" (the first at 48 m and the second at 52 m) could ever have been reached by water.<sup>7</sup>

It has to be mentioned here that neither a regular horizontal growth of the city, as indicated by the stratification of Marshall/Mackay, nor real flood deposits separating one stratum from the other can be identified in the city. This stratification based on regular horizontal growth has been outdated now for a long time (see e. g. Jansen 1984b). A revised stratification, at least for DK-G, is under preparation by the author.

As long as we cannot clearly identify different phases and periods we cannot identify "flood deposits" separating them.

The morphological analysis of sediments (Dales, G., Raikes, R. 1986) and their primary/secondary position within architectural context plays an important role but cannot be discussed here. However, it is anticipated, based on longterm observations, that the sedimental material identified within the architecture as "flood-deposits" is not in primary but in secondary position.<sup>8</sup>

**The vertical extent of the site: the question of the "many cities".**

From the very beginning of their research the excavators were keen to reach virgin soil. Several attempts at deep digs can be recorded (see Jansen SAA 1985 in print: plate III) (Fig. 1) a few of which are listed below:

Table 2

—	VS-area	1925 DD 1-4 (Marshall 1931: 223, 227, 231, Jansen SAA 1985 in print)
—	DK-G	1932 (Mackay 1938: 42-45, Pl. XV, Fieldbook for the year 1932 No 1-123, Karachi)
—	Citadel	1950 (Dales; Kenoyer 1986; Jansen SAA 1985 in print)
—	UPM site	1965 (Dales; Kenoyer 1986)
—	a well in SD	1986 (Ardeleanu-Jansen, under preparation)

In addition to these data, reports on drilling by WAPDA (Khan 1973: 135) are available and show "bricks and pottery" down to 70 ft below surface (approx. 25.70 m a.m.s.l.) in the "old site".<sup>9</sup>

As fig. 1 and table 2 show, the deepest dig (Fig. 1, No 2) in VS area goes down to 42 m a.m.s.l. Sahni (Marshall 1931: 223) thus writes: "A small plot, 25 by 30 ft (DD2 in the plan), to the south of this house was dug down to a depth of 36 feet below the surface, where water was reached, but not the virgin soil. The excavation revealed the existence, superimposed one above the other, of structural remains belonging to the three latest cities<sup>10</sup> and remains of other structures underneath them . . . ." In the lowest levels an animal jaw and teeth, two terra-cotta phallus-like objects, a flat triangular terra-cotta tablet, and two pieces of conch shell (VS 3137-40) were found 36 feet below the surface.<sup>11</sup>

The entry in the field-book (VS register) gives the date as 24.02.26 and the square 30y/8. The objects are described as follows: 3137: jaw bones and teeth, 3138: 2 chessmen of t.c., 3139: a small earthen vase, 3140: a flat triangular object and pieces of bangles.

The report on deep dig No. 1 (Fig. 1; Marshall 1931: 227-8) seems to be more informative: "The excavation soon revealed the existence of a deep infilling of sun-dried brick laid in regular courses, which continued as far as 21 feet below the surface of the courtyard, where water was reached rendering further digging impossible."

Lowest levels were reached on 25.02.26 in square 30aa/18. At a depth of 18 feet (amongst the sun-dried bricks?) a tooth (VS 3163) was again found along with a terra-cotta animal (VS 3162) and a t.c. cone (VS 3164).

At first glance it is surprising that in DD1 water was reached at only 21 feet, while in DD2 it was reached at 36 feet, a difference of 15 feet.

Not the horizontal location (DD1 is located at the western edge of VS-area), but the elevation (through levelling of the Aachen project) provides the answer: the surface of DD1 lies more than three meters below that of the other deep digs. Furthermore, the position marks a western limitation which might be similar to that found by Wheeler in 1950 west of the "granary", where he discovered a huge mud-brick wall below the surface.

Mud-bricks are also reported from deep dig No 3 (Marshall 1931: 225) but only down to 6-7 feet. "A rectangular pit, 30 feet long from east to west by some

12 feet wide, was sunk to the depth of 6 to 7 feet through the filling but disclosed nothing of interest."

During deep digging in the stupa area B. L. Dhama, under the supervision of John Marshall, came across a "lofty platform" (Marshall 1931: 125) below 19 ft.<sup>12</sup> "The intervening space is occupied almost entirely by crude brick or alluvial mud heaped up artificially so as to form an immense platform over the whole of this stupa area . . . For the support of this platform stout retaining walls would be indispensable, and portions of such walls have been unearthed on the east and west . . . The western retaining wall (TT) follows a north to south line immediately below the western limits of the monastery . . ." (ibid.: 125) Even in the lowest levels 40 feet below the buddhist pavement (approx. 43 m a.m.s.l.), which were represented by a "low wall and adjacent pavement" (ibid.: 127), potsherds were found which were "in all respects similar to those unearthed at higher levels" (ibid.: 127).

More informative are Mackay's reports (1938: 42-43) on his deep digs. In the very center of DK-G south (Bl. 7, ho 1) he went down about 40 feet (approx. 35 m a.m.s.l.). He had to cut through a mud-brick platform, the base of which was reached 28 feet below datum level<sup>13</sup> (45.93 m a.m.s.l.). Below it, a layer of rubble consisting of broken bricks, potsherds and rubbish extended down to 35 feet below datum. On March 7th 1931 the sub-soil water was reached at a depth of 38.5 feet below datum (42.74 m a.m.s.l.). Below the filling of rubbish and potsherds Mackay traced "a layer of stiff clay with occasional pockets of grey sand" (Mackay 1938: 44) which, according to him, was the clear evidence of a flood. According to this report, 2.10 meters of potsherd and rubbish filling were followed by a further two meters of mud-brick filling in this area. The fact that the lower filling consisted of potsherds and rubbish seems to indicate that this elevated area<sup>14</sup> was constructed while the settlement was already inhabited at larger scale, thus producing a considerable amount of rubbish.<sup>15</sup>

It is important to mention that remains of only small houses were always found in the lowest levels, one of which Mackay comments on as follows: "From the fact that broken material enters into their construction they were evidently not merely material piled up ready for removal elsewhere, and it seems likely that they were rough shelters thrown up for men who were employed to remove the bricks of earlier buildings." (Mackay 1938: 43) One of these huts was found at a depth of 31 feet below datum (45.17 m a.m.s.l.) on a foundation of rubble, obviously the upper level of rubble on which the mud-brick platform was constructed. At the same level not only the lowest foundation walls of a "large building" (block 10) begin, but also those of the great east-western wall belonging to block 1.<sup>16</sup>

Between these two buildings there ran a drain at 30 feet below datum (45.47 m a.m.s.l.) with a slope to the east. So far this is the lowest proven level of a construction

period indicated by a drain in the "lower city". It coincides in height with the lower drain in Wheeler's cross-section west of the "granary" (Wheeler 1968: opp. 44).

But Mackay wanted to go deeper. By the end of April 1932 he asked Mr. Puri, the later joint excavator of Moneer-site and then custodian of Mohenjo-Daro, to go as deep as possible.

At a level of 37.4 feet (approx. 43 m a.m.s.l.) Puri traced "three courses of sun-dried bricks at one side of the pit" (Mackay 1938: 44) obviously the same level where Mackay saw deposits of a flood, 6 feet deeper (41.20 m a.m.s.l.) "a layer of potsherds was found most of them nondescript in character..." (ibid.: 44).

Some of them were depicted in Mackay 1938: Pl. CXII and seem (besides the small pottery model of a socketed axe) to be familiar<sup>17</sup> within the Harappan context.<sup>18</sup>

Mackay writes: "In general, nothing found in the excavations in the Early strata suggests any break in cultural continuity between the Early and the Intermediate Period..." (ibid.: 44).

### Conclusion of the earliest deep digs

A summing up of the different records of deep digs in the twenties and thirties does not lead to very much, as proper cross sections were not drawn and the descriptions are quite vague. Nor do the few photographed potsherds give proper information about an earlier settlement as suggested by Rafique Mughal (1971: 77ff). Structurally speaking, we have records of mud-brick fillings or platforms in different parts of the site, such as in VS area, but also in DK-G area. No major architectural structures are proven below 45 m a.s.m.l. Platforms can appear in most different forms, as fillings of a single room to elevate one part of the house (e.g. house VIII, HR-A) or to fill large areas, courtyards etc. as shown by the examples in HR-B and DK-G. They can also form a substructure for a house, as is the case in the stupa area below the "monastery", in L-area below the "assembly hall", in HR-A below house VI and in many more examples.

Obviously we are not dealing merely with "platforms", but with quite a complicated system of artificial elevations used for different purposes. The platform in the "stupa" area definitely served a different purpose than that in the deep dig in DK-G.

For Marshall and Mackay, they were all — their different absolute height a.m.s.l. left aside — protections against floods. As soon as one studies the three-dimensional growth of this "giant" in more detail, it becomes obvious that this interpretation of a very sophisticated system of artificially constructed elevations within the urban context is too simple.<sup>19</sup>

### Wheeler's deep dig 1950

Another major source for the study of the vertical extent of the site was Wheeler's deep dig in 1950 (Wheeler 1968).

Wheeler's cross-section shows for the first time stratified layers at the western edge of the "citadel" (ibid.: opp. 44). All in all, three different interpretations of this drawing exist: the original, unpublished<sup>20</sup>, the published one by Wheeler (1968: opp. p. 44) (Fig. 2) and the published one by Alcock (Dales, G.; Kenoyer, M. 1968: 499)<sup>21</sup> (Fig. 3). The most precise one is the unpublished plan.

Without going into greater detail, the following observations can be made:

From the surface (approx. 49 m a.m.s.l.) Wheeler was able to dig down to approx. 41 m a.m.s.l., which coincides with the deepest digging of Mackay in DK-G area (Fig. 1, 12; Fig. 2, Fig. 3). Yet he was not able to reach virgin soil.

If the settlement does not continue west of the "citadel", we have with this "mud-brick bund" the first definite margin between occupied and unoccupied areas which is of paramount importance for the study of the silting-up of the surrounding plain.<sup>22</sup>

Wheeler differentiates between 5 phases? (almost from bottom to top - number 3 and 4 seem to be mixed up (Wheeler 1968: 44) (Fig. 2).

Alcock differentiates between 11 phases? (somehow from top to bottom in a slightly curious way of numbering) (Fig. 3).

Without offering a third system the cross section may provisionally be commented on as follows:

The mud-brick bund seems to have been erected in at least three stages: stage 1: the lowest, smaller part 45 m a.m.s.l. and lower, stage 2: the upper (above 45 m a.m.s.l.) inner extension (2D Alcock), stage 3: the upper outer extension.

The construction of "drain A" (9 Alcock) (if it is a drain) and the "floors" to the west (6-8B Alcock) could have coincided with stage 1. If this was a drain, then the

"floors" might represent layers of a street constructed against the oldest bund.

The construction of "drain B" (if it is a drain, as it has no bottom) could have coincided with stage 2, with another street at the level of approx. 49 m a.m.s.l., repeating the pattern of before. Wheeler's so-called "floors" in the lowest levels are, according to Alcock, charcoal-layers and hearths. But they could also be simple secondary deposits of rubbish.

Whatever the interpretation may be, one fact remains: the structures go down to at least 41 m a.m.s.l. (8 m b.s.) and these structures were not sunk into ground in those days. On the contrary, wherever architecture was constructed, one tried to construct on elevated ground, as was obviously the custom in the active alluvial plain of the Indus.

But pits which must have been located outside the settlement were dug in clay layers for the production of bricks and pottery, as can be found even today in the villages of the region.

If the "mud-brick bund" had been constructed directly on the plain, or even on earlier anthropogenic strata (as seems to be the case in Harappa), and not in a depression, then the ancient plain around Mohenjodaro must have been lower than 41 m a.m.s.l.<sup>23</sup>

If we calculate the amount of clay and sediments for the construction of two platforms, one for the "citadel" and one for the "lower town", based on an average height of 5 m, we receive a figure of about 4 million cubic meters (about 400,000 cubic meters for the citadel) without counting the millions of bricks.

The pits dug for the clay were most probably located close to the platforms, and might have surrounded them. This amount taken into consideration, both platforms could theoretically have been surrounded by a ditch at least 5 meters deep and more than 100 meters wide which, once filled with water, became a sort of moat, and together with the platforms served as a fortification similar to the early-historical cities in the Ganges-plain (e. g. Jansen 1987b: 150; Schlingloff 1969: 106, 118) (Fig. 4). This would explain why no one has ever found fortification walls, and also why pottery fragments and brick-pieces were found at a greater depth. They would represent a secondary position, rubbish which was thrown into the ditches.

Whether depressions outside the settlemental area can be identified as pit areas for the construction of the platforms or as a branch of the Indus (see Cucarzi, this volume) seems for the time being of secondary importance<sup>24</sup> in the hierarchy of questions. But having taken a closer look at traditional settlemental behaviour in lower Sind it seems impossible to me that the Indus, or a branch of it, flowed at a distance of only 10 meters from the site.<sup>25</sup> On the other hand, people used to take clay for their houses out of nearby pits which later, filled with rain-water, became the village pond.

According to common tradition, which can be observed even today in the region, construction material is taken

from places as near as possible.

The densely built houses also point towards a very limited and not easily extendable occupation space, whereas the straight thorough-fares might represent a direct connection between the entrances, which, in our case, would have been ramps, as are reported from Harappa. This may be a reason why at the southern and northern end of "First Street" no city gates have been found, as one would expect for a walled city. Returning to Wheeler's cross-section, one can observe that the "mud-brick bund" had an inner filling which (up to 46 m a.m.s.l.) seems to consist of "mud and mud-brick debris" in the lower part. Only in the upper strata (from 46 m a.m.s.l. onwards) it is possible to observe a substructure of the "granary" made of mud-bricks.<sup>26</sup>

If the structure cut by Wheeler's deep digging continued further on, then it might represent a complete retaining construction of mud-bricks with an inner filling of alluvial sediments, thus forming a gigantic platform on which other structures (as the "granary" shows) were erected.<sup>27</sup>

Another important factor is that the filling does not necessarily have to consist of mud-bricks<sup>28</sup>, which is extremely important to recognize, especially for geophysical surveys, since secondary alluvions cannot be distinguished from primary ones. The case becomes even more complicated if it starts to rain during the period of filling-up the inner space of the retaining wall (400 x 200 m, at least 5 m high).

Who would be able to differentiate between the hydraulic deposits of a mud hole or a little lake thus formed within the retaining wall by a "stagnant water deposit" and "flood deposits"?<sup>29</sup>

Furthermore, an extraordinary infrastructure both for the planning body and also for the executive one<sup>30</sup> was necessary to construct a platform of approx. 400,000 cubic meters. The workers would definitely have built temporary huts for the supervisors on the growing platform, they might even have had a fire at night. All these traces may be visible in a cross-section and could have been found by the excavators of Mohenjodaro as described above, not as strata of different phases over a long timespan but as strata of a very short construction period.

### The horizontal extent of the site: a question of the nucleus and the periphery

First remarks on the extent of the site were made by Marshall (1931: 9). "What extent of ground was covered by this city at successive periods has yet to be determined. On the east and north of the mounds traces of ancient occupation, in the shape of low tumuli or prehistoric potsherds strewn over the face of the plain, can be seen for a space of half a mile or thereabouts, and to a lesser distance on the west and south; but whether these areas were once included in the city proper or were merely parts of its extra-mural suburbs is uncertain. One thing, however, that is clear beyond question is that the existing mounds have been greatly reduced in size by the incessant erosion of their sides, and that the ancient city, therefore, must have extended well beyond their existing limits."

Two agents of destruction were obvious to Marshall: 1. silting-up of the plain through the Indus deposits and 2. erosion.

The results of the interaction of these agents are visible today. Marshall mentions an area of 240 acres (960,000 square meters) (*ibid.*: 1).

Mackay wanted to know more about the horizontal extent of the site. In 1931 he cut several trenches in the periphery of the site (*Fig. 5*) in search of a city wall<sup>31</sup> which might have given a precise idea about the actual size of the city.

One trench cut through mound H (*Mackay 1938: 1*), about 100 meters north of DK-G, brought to light a huge rubbish heap consisting of broken pottery, ashes and humus which could be traced down to approx. 43 m a.m.s.l. where, close to the water table, some traces of masonry were found. Mackay thought this was the municipal rubbish area and thus formed the northern limit of the city. Even in cutting further trenches he did not come across "city walls". Extending further north for about 500 feet (approx. 150 meters, the area where the PTDC guest-house stands today) he came across buildings of good, though now ruined masonry, the foundation levels of which he could not trace due to the water-level reached on January 13, 1931 at a depth of 34.2 feet (approx. 44 m a.m.s.l.). In other trenches (south of DK-G and in the depression between L- and SD-area) he did not find structures, but he found what he thought to be evidence for the already discussed floods.<sup>32</sup>

The first, and up to today the only model of Mohenjo-Daro as a whole has been proposed by Stuart Piggott (1945) and was later adopted by Wheeler (1953: 25) (*Fig. 6*). It shows Mohenjo-Daro as a "roman oppidum" on a rectangular plan, 1211 meters north-south and 1028 meters east-west, thus covering approx. 1,250,000 square meters in total, cut by three north-southern and two east-west streets, thus forming 3 x 4 blocks,

with the "citadel" as the middle western one. It has served in recent times for different reconstructions of the city, e. g. that in the Mohenjo-Daro museum (*Fig. 7*).

The most important information about the horizontal extent of the site was obtained during the last years of our research at Mohenjo-Daro. We received not only reports from farmers in near-by villages who had come across brick walls in the ground while digging wells, but also reports from river people who had seen brick-walls washed by the Indus.

First concrete information outside the limits of the topographic maps came through the construction of the collector drain for the UNESCO-project around Mohenjo-Daro. This drain, constructed at an average depth of approx. 45 m a.m.s.l., cut through archaeological ground (*Fig. 8*) in areas south of the "citadel" (in *Fig. 8* marked I), south of Dales' excavation (marked A), south of the "lower city" (marked C) and east of the "lower city" (marked B). Especially in I, A, and B, structures immediately below surface were cut. The number of structures in A was so enormous, that the original plan of WAPDA had to be abandoned and a loop was constructed around the center of underground structures in A. Surface surveys by the author have clearly shown mature Harappan deposits.<sup>33</sup>

Area C consisted mostly of debris which seems to be an extension of the huge rubbish deposits south of HR-area where no major structures were found.

A further surprise came in 1985 when, about 500 m east of the "limits" of the "lower city", a new dam was constructed by WAPDA. Bulldozers came across Harappan structural remains<sup>34</sup> approx. 2 meters below surface. The area formed by a small hill was covered with blackish nodules, as were known from the surface of Mohenjo-Daro. Here, Mark Kenoyer found wasters of *Turbinella pyrum*, indicating that this place had been used for opening the gastropods. At that time we took some measurements and some levelling of points.

The most recent surprise came this year, 1987<sup>35</sup>, when WAPDA constructed a spur inside the bed of the river Indus, close to a Peer's tomb. Here as well, about 2 km away from the "citadel", people had reported burnt bricks with which they had constructed the tombs of some saints buried there.

During the construction work a huge area, about 200 meters long, of mature Harappan structures was exposed. An emergency excavation under the directorship of M. A. Halim brought to light several rooms, streets, and wells. Several seals were found.<sup>36</sup>

Without giving too many details before the material is published by the Department of Archaeology, this discovery has to be commented on more precisely. Architectural remains seem to continue for almost 2 kilometers, at least to the east of the site. Their uppermost strata are below the present surface of the plain at a slightly varying height of 44-46 m a.m.s.l. They represent the (Late?) urban phase. Some tests

east of area B (Fig. 8, eastern limit of the "old site") show no deposits for some distance.<sup>37</sup>

The major question resulting out of these fragmentary observations is: do these settlement areas belong to the centre of the city, to the "intra-mural" part, or are they suburbs which surrounded the city like satellites? Another question is: were they also constructed on platforms as a protection against the floods?

These questions have to remain unanswered as long as no further data are available.

But it is obvious that with these discoveries a new chapter of research has started, dealing with "platforms" and with "suburbs". A new strategy for such type of research is needed, dealing with macrostructural questions. The bulldozers, through which those discoveries have been made, can also be part of this strategy in helping to remove the upper alluvial layers which seem to hide large occupational areas in the plain.<sup>38</sup>

## Conclusion

Mohenjo-Daro has changed a great deal. It is no longer limited to the good old isohyptic lines as can be seen in the Francis- or Wanzke-plan.

If it was — during its urban phase — a planned platform-based city, then this would indicate an enormous step, not only politically, but also financially and organizationally regarding the effort to construct it. This step would have coincided with the appearance of seals, script, burnt-brick technology, hydrological technology such as circular wells constructed with wedge-shaped bricks, drains and bathing-platforms.

We are dealing with a rather small time gap of not more than 80<sup>39</sup> years around 2400 B. C. where all these elements must have been developed, most probably not in Mohenjo-Daro, but in a place close enough to the active alluvial plain to study the river carefully. It seems that the first urban settlement of Mohenjo-Daro was constructed as a whole in a very short period of only a few years, equipped from the beginning with vertical water-supply systems such as the wells, which could hardly have been constructed later when the city was already flourishing.<sup>40</sup>

Of course, many alterations took place during the history of the city, both horizontal and vertical ones, as can be seen by Wheeler's cross-section and by the

change of orientation systems (see Wanzke, this volume) of which we still know almost nothing.

Despite the great difficulties of reconstructing later alterations, the beginning of the urban phase now seems easier to localize.

The platforms here play an extraordinary role, not only as "founding-platforms", simple artificial elevations constructed as a protection against the floods, but also as an iconographic element of elevating specific areas and structures. And this seems to be the case not only in Mohenjo-Daro, but also in other mature Harappan cities like Harappa, Kalibangan and Lothal. From this point of view, the "citadel" as an urban concept in a mature Harappan context in general, and in Mohenjo-Daro especially, covering here approx. 80.000 sqm, is the largest artificially elevated area as part of a city known in the third millennium.

Regarding our "model" of founding platforms (see e. g. Jansen 1985), the approach was, out of deductively collected research-data, to formulate a dynamic hypothesis which had to be differentiated according to the availability of further data.

Meanwhile a differentiation has become possible through additional research (see *Interim Reports Vol. 3*, under preparation), which more and more substantiates the idea of substructures, the appearance of which the author interprets as an initiative action to mark the beginning of the mature Harappan period at Mohenjo-Daro.

There is still hardly any proof for an earlier settlement below mature Harappan layers at Mohenjo-Daro, which, of course, should not be overinterpreted, as almost no research has been carried out in lowest levels where such indicators are expected to be found.

Regarding the existence of an earlier settlement at Mohenjo-Daro underlying the mature Harappan structures, the question has to be raised whether in principle a settlement in the lower Indus-plain could have existed without being constructed on (artificially?) elevated ground on a long-term basis, which would thus have been permanently endangered by the Indus-floods. Whereas in the Punjab early (pre-) Harappan settlements are reported in the alluvial plain, none are known so far in Sind.<sup>41</sup>

Leaving aside for a moment this discussion, the more interesting question seems to be whether the mature Harappan settlement (the city with an "acropolis" of about 80.000 sqm and the "lower city" with about 800.000 sqm!) was the "invention" of the inhabitants of an earlier settlement at the same place, or whether the locus "Mohenjo-Daro", with or without an existing earlier settlement, was chosen for whatever reasons as "central place" by a recently risen culture of the area, which can be identified by a script, a specific production technology and by specific engineering techniques such as circular wells, drains etc.

Having raised these questions we are back to the old discussion, not only about the location of the "epicenter"

of the mature Harappan culture but also about "pre", "proto", "early" and "mature" Harappan periods.

If the mature Harappan period is marked by founding platforms as a basis for a large scale urban planning<sup>42</sup>, as seems to be the case at least at Mohenjo-Daro (and probably also at Harappa, Kalibangan, Lothal, Banawali etc.), we are dealing with an extraordinary engineering architecture which must have been perfected together with all other mature Harappan elements somewhere in an area close to the alluvial plain, but still beyond the reaches of flood-water, such as the Kachhi-plain, the Gomati area, the Ghaggar Hakra area etc..

The construction of the big cities such as Mohenjo-Daro or Harappa, within the immediate reach of the big but dangerous water-ways as transport media, may have been the "first" action of the already existing mature Harappan culture. In this case, the locus of the big cities was not necessarily the primary place where this cultural development took place, but a secondary one which was chosen for strategic, economic, trade and other reasons. The construction of the cities was based on an already fully developed new technology.

If these assumptions are correct, we are still looking for the starting place or area where, most probably in a rather short period of not more than two to three generations, the mature Harappan culture could have received its final shape, with all known elements, before it started to expand explosively all along the water-ways and along the coastal areas.

It would not be surprising to find that the expansion was based on new means of transport by ship, necessitating settlements close to the river. And this settling was based on the engineering technology of artificially elevated settlements. From that moment onwards there were no longer any limitations to the exploitation of the Greater Indus Valley and to travel, even beyond to foreign countries.

## Footnotes

- 1 The author was able to investigate bricks which were discovered in 1980 in a well at Hasan Wahan village approx. 1.5 km north of Mohenjo-Daro.
- 2 Further drilling in 1985/86 by the ARPM with Pyrkauer drill did not prove major flood deposits. Results of drycore drilling by M. Cucarzi and his team have not yet been accessible for the ARPM.
- 3 Gen. 7, 17-6, 22.
- 4 Mackay's periodization differs from that of Marshall. According to the "flood-deposits" between Late III and Late II he suggests that Late III should be regarded as the uppermost stratum of the Intermediate Period. According to him "there is also strong evidence that the Intermediate III phase should really be regarded as the last phase of the Early Period" (Mackay 1938: XIV).
- 5 Recent drilling points towards a slow process of aggregation in the vicinity of the site. Final proof can only be obtained by a geological cross section outside the retaining wall in the colluvial zone.
- 6 The width of the Indus valley with approx. the same isohyptic sloping is up to 200 km! the inclination towards the sea less than 1%. Even with a higher gradient (see Raikes 1965) a flood in the plain (not in the riverbed) could hardly have reached that height. According to the Gazetteer of Sind 1907: 11-13 the speed of the river varies, e.g. at Sukkur from 0.5 m/sec in January to 2.8 m/sec in the summer, taking into account that Sukkur is a gorge. The speed in the plain is much lower. The shifting of the maximum rise of Indus water-table from Sukkur (4.20 meter) to Kotri (5.62 meter) (ibid.: 12) takes 17 days over a distance of 455 river kilometers (291 km as the crow flies) which makes an average speed of 0.31 m/sec (455 km) or 0.20 m/sec (291 km). Floods coming from the Himalaya zone would have had to cover a distance of more than 1000 kilometers and an area of approx. 1 million sqkm before they would have reached Mohenjo-Daro!
- 7 Except by the dam anticipated by Raikes.
- 8 E.g. textural appearances of "still-standing water deposits" have been observed in the site after heavier rains or the intensive use of water.
- 9 The 18 inch drill hole shows bricks and pottery between 65 and 70 feet on a layer of sandy clay and sand. This layer of bricks and pottery is separated from the next higher stratum of bricks by 25 feet of clay, 4 feet of sand and 1 foot of clay.
- 10 Sahni had obviously been influenced by Marshall's "three periods".
- 11 Here the surface is at 53 m a.m.s.l., which makes the lowest depth approx. 42 m a.m.s.l..
- 12 Below the lowest buddhist pavement.
- 13 178.7 ft a.m.s.l. = 54.47 m
- 14 One has to be very careful not to overinterpret these data, as we know from other areas that such fillings might have only existed within the limits of one house!

- 15 Even today it seems common use in this area to fill depressions with rubbish and specially with potsherds and bricks, as there is no other material as package or proper foundation in the silty alluvial ground. The huge agglomeration of kiln wasters, potsherds etc. south of HR-area piled in heaps, seems to have been a central storage place for such needed packing material.
- 16 See Mackay, E. 1938: XVa-e.
- 17 For a different point of view see Mughal, R. 1971: 77 ff.
- 18 See e.g. Dales, G.; Kenoyer, M. 1986: 307.
- 19 More than 300.000 level-points have been taken by the German Research Project all over the site in order to allow a three-dimensional study.
- 20 This drawing came into our hands through Leslie Alcock and Maurizio Tosi. To both we are extremely thankful.
- 21 A separate publication on the Wheeler excavation is under preparation.
- 22 As the horizontal silting-up, over a long timespan, against a vertical unit constructed in a short period can be observed here.
- 23 Marshall (1931: 9) suggested a level of the ancient plain "some 25 to 30 feet below its present level". The silting-up rate of the Indus has been calculated at 20 cm/100 years (see Jansen, M. 1979: 42; Gazetteer of Sind 1907: 10).
- 24 Especially with geophysical methods it is almost impossible to differentiate between a natural depression and an anthropogenic one close to the settlement (distance in HR south from the houses to the depression hardly 10 meters). In both cases the filling would consist of colluvial material. Perhaps a drilling profile based on 1 m drill distance might help.
- 25 The Indus is a complex meandering river system with enormous fluctuations of water during the year (in summer 16 times that of winter). No settlement was ever founded immediately to its banks, apart from Sukkur, Hyderabad and Thatta which are in close vicinity of rocky outcrops.
- 26 Exactly the same method of back-fillings can be observed in the cross-section of Harappa (Wheeler, M. 1968: opp. p. 30).
- 27 Investigations by the Aachen University team in 1986 have clearly shown that this retaining wall exists around the whole "citadel".
- 28 The south-western corner of the "citadel", even today more than 7 meters above ground, consists of an outer surface made of mud-bricks and an inner core of pure sand!
- 29 During the winter rains in Mohenjo-Daro in the last years DK-G-area was quite often completely submerged. It took some time before this big mud-hole dried out again. One could easily get stuck in the mud for half a meter.
- 30 This platform could have been constructed by 2000 labourers within 6 months based on an average of 1 cubic meter/person/day.
- 31 The existence of a city wall was already discussed with Marshall in 1931: 44. The existence of defence walls was not only important to determine the limits, but was an ideological question, as can be concluded from the later discussion between Vere Gordon Childe (the peaceful, nonviolent aspect of the Harappans) and Mortimer Wheeler (the grim fort of Harappa and the destruction by the Arians).
- 32 At least for the digging north of the L-area we can state today that this "flood deposit", "a very closely packed clay mixed with potsherds" (ibid.: 3) was the mud-bricks of the sub-structure which interestingly enough were not recognized by Mackay.
- 33 An emergency excavation in this area brought to light an "Iron Age" culture. Publication is awaited.
- 34 This was first recorded by our colleague G.M. Shar.
- 35 Although this should not be part of Interim Report II, I think it is important enough to be mentioned here.
- 36 Mrs. Ute Franke was allowed to assist and to carry out some Pyrkhauser drillings which showed a continuation of anthropogenic material down to three meters (approx. 41 m a.m.s.l.).
- 37 This might support the profile shown in fig. 4.
- 38 In Germany (Aldenhofen Platte) bulldozers have been in use in emergency excavations for several years in order to trace archaeological remains in a pit-mining area.
- 39 Jim Shaeffer also mentions such a period before the final appearance of the urban forms with all their consequences (in an unpublished essay).
- 40 We carried out a well excavation in 1986 south of SD-area (Ardeleanu-Jansen, under preparation) and reached at about 13 m depth (approx. 35 m a.m.s.l.) the watertable without having reached the bottom. Such wells cannot have been constructed in an open pit. A separate book on the water supply and sewage systems is under preparation for the Frontinus-Gesellschaft, Köln.
- 41 Of course this might be due to their submersion in the alluvions of the Indus.
- 42 The mature Harappan sites in Mohenjo-Daro, Harappa and Kalibangan are at least 20-times larger than the largest "early" Harappan site which, besides other factors, clearly marks a complete different settlemental behaviour.

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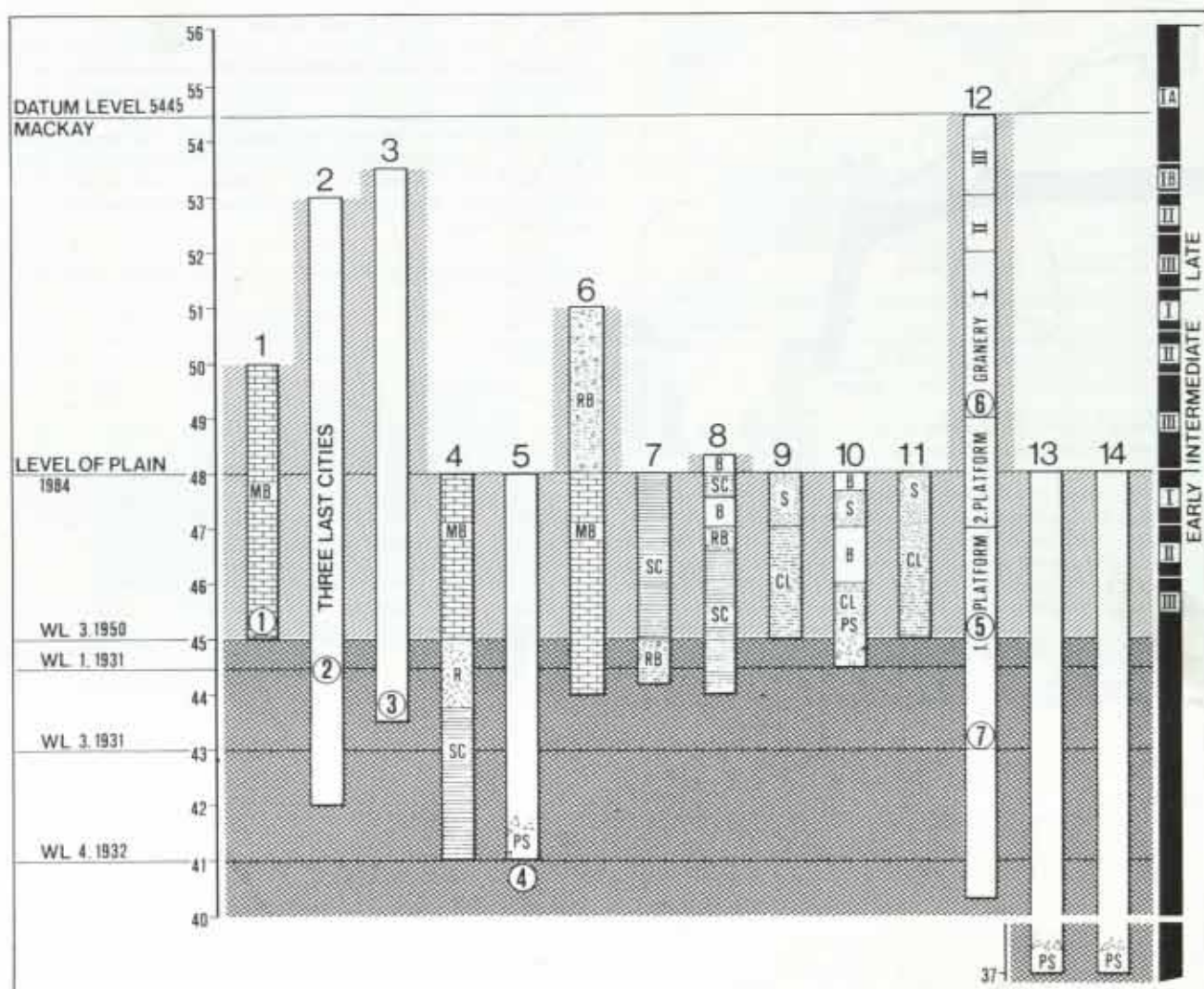


Fig. 1 Diagram showing systematically the different deep diggings at Mohenjo-Daro.

Columns:

- 1 Deep digging VS-area (DD1) (Marshall 1931: 227)
- 2 Deep digging VS-area (DD2) (ibid.: 223)
- 3 Deep digging VS-area (DD4) (ibid.: 231)
- 4 Deep digging DK-G area (Mackay 1938: 43-44)
- 5 Deep digging DK-G area (ibid.: 44). Excavation carried out in Bl. 7, room 3 by K.N. Puri who joined the excavation in Moneer area in 1934
- 6 Trench H (ibid.: 3)
- 7 Trench 574 ft from edge of site (ibid.: 3)
- 8 Trench 40 ft from edge of DK-G (ibid.: 2)
- 9 Trench between DK-G and stupa area (ibid.: 4)
- 10 Trench between L-area and southern face of stupa (ibid.: 3)
- 11 Trench north of stupa, close to site 3 (ibid.: 5)
- 12 Deep digging Wheeler (Wheeler 1968: 44)
- 13 Deep drilling WAPDA (after Aryne 1972)
- 14 Deep drilling UMP site.

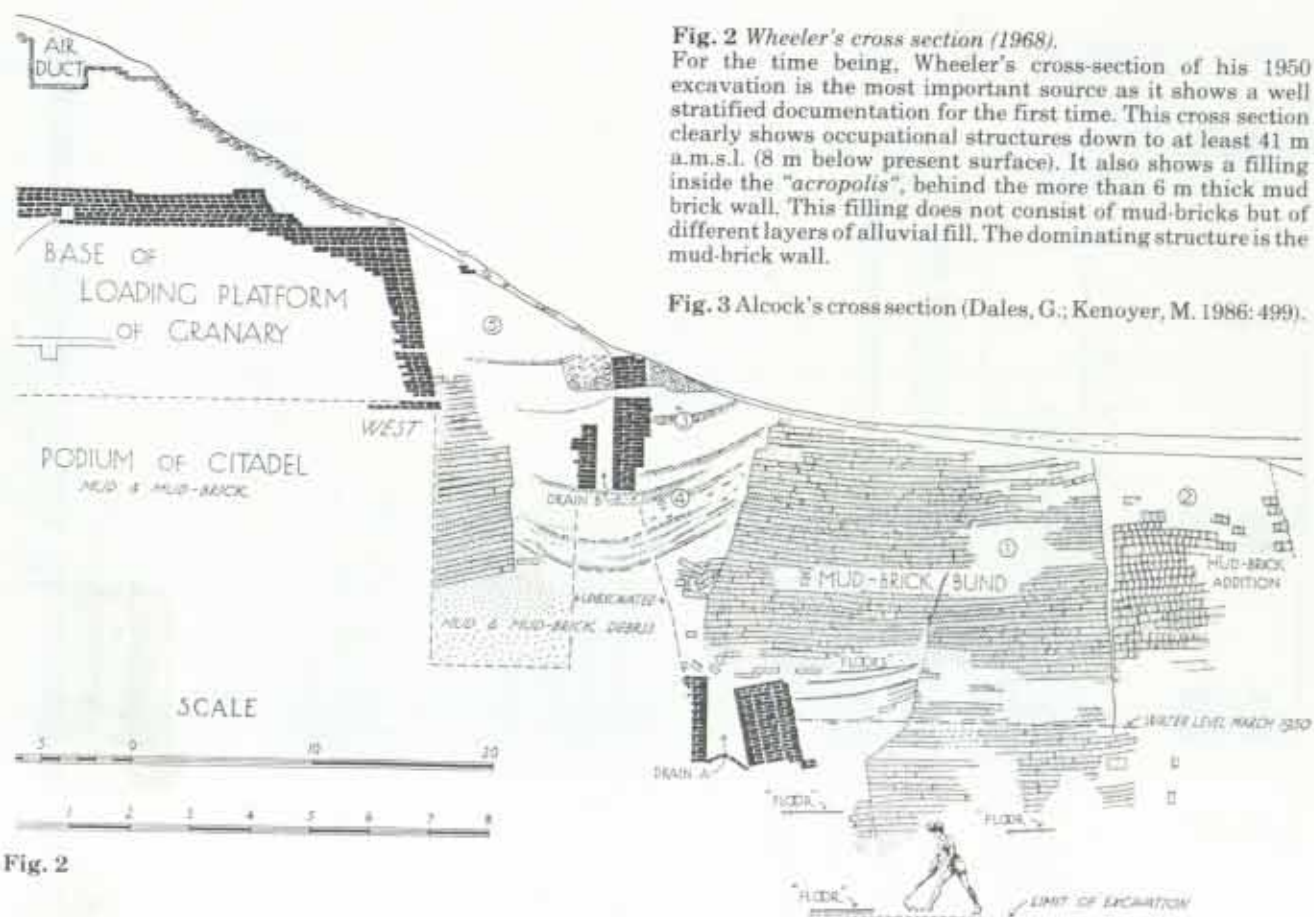
Legend:

- 1 terracotta animal VS 3163
- 2 animal teeth VS 3028-32
- 3 remains of structure
- 4 charcoal ashes
- 5 1st street
- 6 2nd street
- 7 "floors"

Abbreviations:

- B = bricks  
 CL = clay  
 MB = mud-bricks  
 PS = pot-sherds  
 R = rubble  
 RB = rubbish  
 S = sand  
 SC = stiff clay  
 ST = structures

The present average level of the surrounding plain in Mohenjo-Daro is reported as approx. 48 m a.m.s.l. (a bench mark is at the museum). The datum level of Mackay's excavation to which also Mughal referred (1971: 77, note 90) is 54.45 m. The different water tables (in the diagram on the left) show high fluctuation especially in the winter months. The cross-hatched part below 45 m indicates the hypothetical first structural phase of the "founding" platform, whereas the hatched part indicates the later additions. The right part of the diagram shows the corresponding stratigraphy according to Mackay (1938) in black.



**Fig. 3** Alcock's cross section (Dales, G.; Kenoyer, M. 1986: 499).

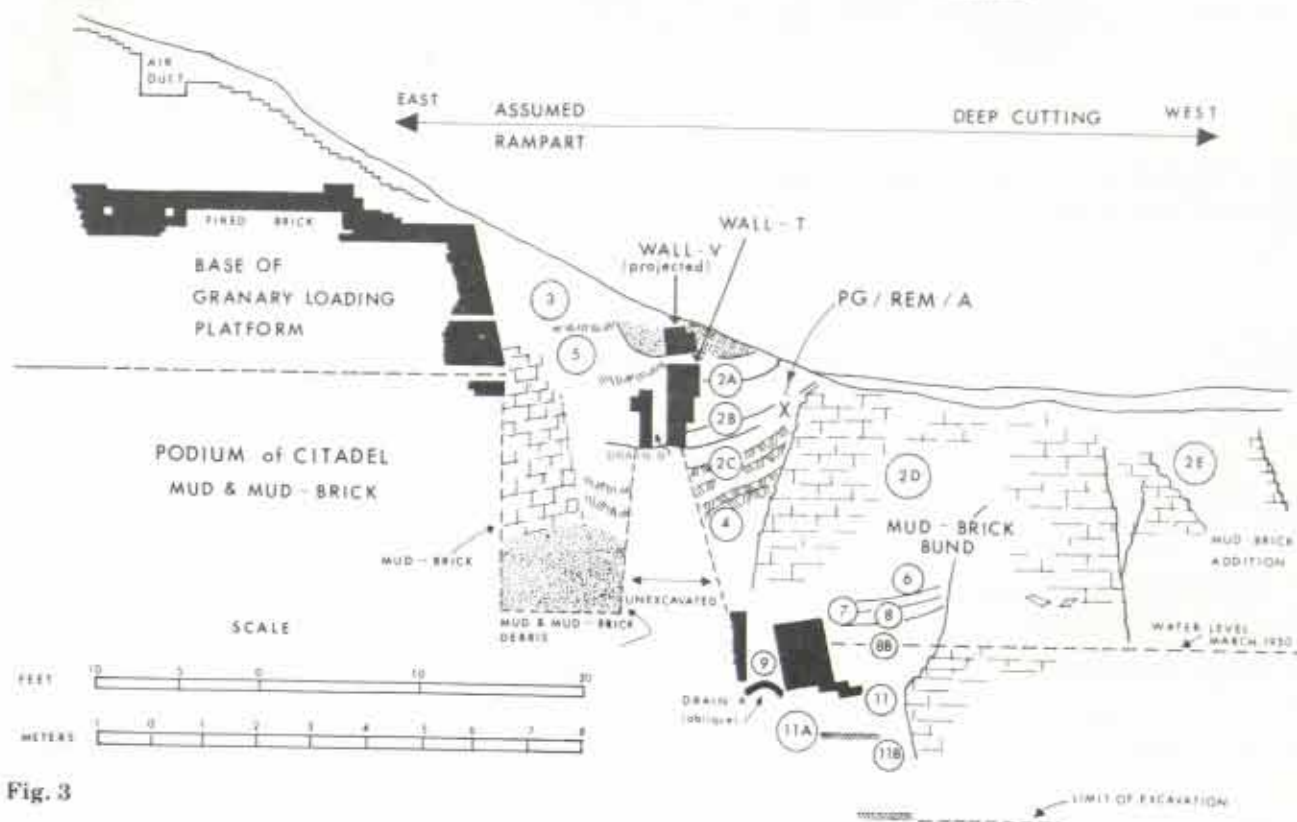
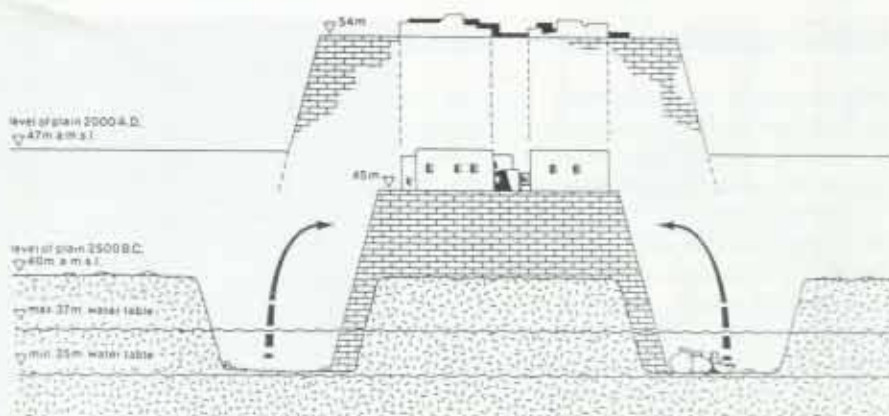


Fig. 4 Cross-section of the "citadel" area, Mohenjo-Daro.

The drawing shows the cross-section of a hypothetical idealized reconstruction. It is based on the reports of the different deep diggings, especially on Wheeler's cross-section inside the city, and on the hypothesis that the anthropogenic material of the WAPDA drillings is not in a primary position. As Wheeler did not reach virgin soil at a depth of approx. 41.5 m a.m.s.l., it must lay even lower, at least in this locus. Comparative studies of the width-height of the mud-brick wall at Harappa allowed a provisional assumption of 40 m a.m.s.l. for the lowest level of construction, which should be identical with the ancient surrounding of Mohenjo-daro.

Furthermore, it was assumed that the large wall in Wheeler's cross-section represents a retaining wall surrounding the whole "acropolis" area and which was almost simultaneously filled-in in order to form a large elevated area as a foundation for the earliest architecture on top. 400,000 m<sup>3</sup> of earth had to be moved to construct this platform of approx. 200x400 m, which was probably taken from near-by pits, dug to the maximum depth of the ancient water table. The water table, at its lowest in the winter season, might have lain at at least 5-6 m



below surface, i.e. 35-34 m a.m.s.l. (and even deeper). The anthropogenic layers in the deep drillings might be represented through rubbish which was thrown into the ditches at a later date and which are not primary deposits of lower settlement horizons, as has been assumed up to the present. It is difficult to decide whether the pits outside the platform were dug surrounding the whole "acropolis". The concept of a moat is merely conjectural. But 400,000 m<sup>3</sup> of removed earth would e.g. mean a large ditch of more than 50 m width and 5 m depth surrounding completely the "acropolis".

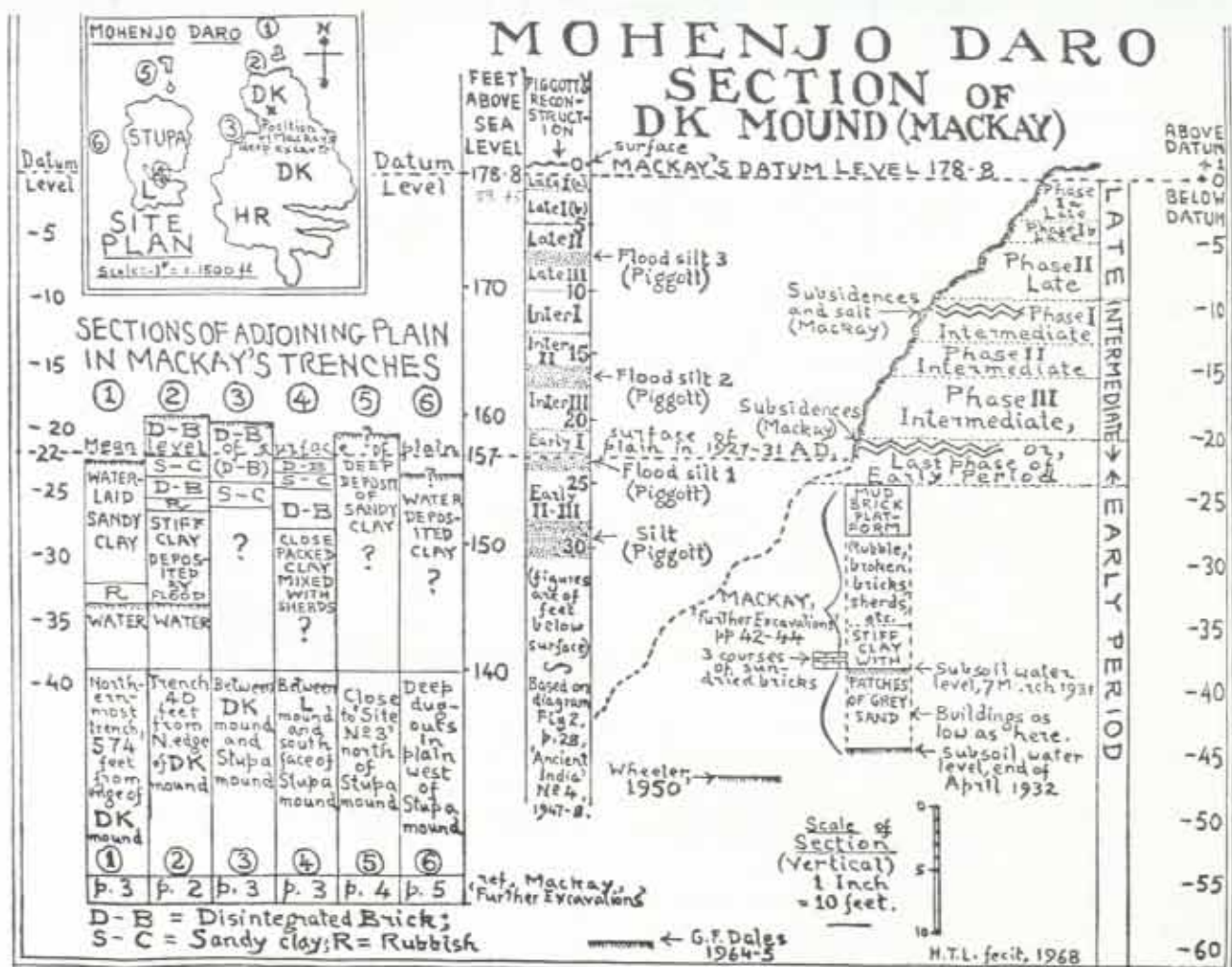


Fig. 5 Diagram Lambrick (1973: 56).



Fig. 6



Fig. 7

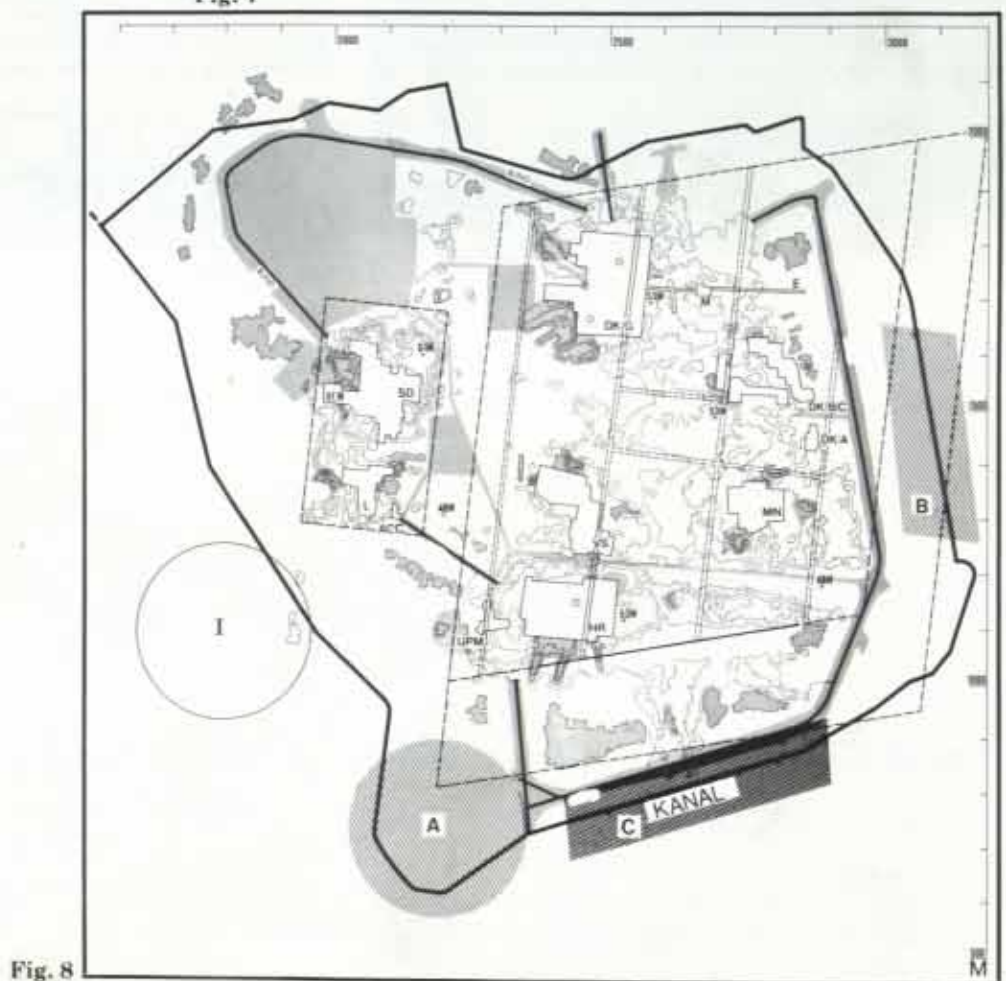


Fig. 8

Fig. 6 Reconstruction of the groundplan of Mohenjo-Daro (after Wheeler 1968: 36).

Fig. 7 Drawing of Mohenjo-Daro (Museum Mohenjo-Daro).

Fig. 8 Groundplan showing Mohenjo-Daro, disturbed areas.

# State of Research on the Architecture in "Moneer" Area, Mohenjo-Daro

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*The aim of this paper is to summarize the present state of the investigation of the DK-I or Moneer Area at Mohenjo-Daro. It is based on the analyses and documentary work carried out by the Mohenjo-Daro Research Project under the direction of Dr. M. Jansen, to whom I am indebted for constructive suggestions and advice. Thanks are also due to Dr. Máire Mulloy for translating the manuscript, to Dr. Anna Sarcina, Mustafa Skalli and Friedhelm Pedde for their analyses on the site, and to all involved in the documentation of the MN Area.*

The Moneer (MN) Area (Fig. 1), in the eastern portion of the excavated area of Mohenjo-Daro, is situated approx. 200 m south of the DK-A,B,C Area and approx. 130 m east of the VS Area immediately north of the depression running east-west between the HR and VS Areas (Fig. 2).

With excavated floor and threshold levels of 53-54.5 m above m.s.l the MN excavated area, which extends over approx. 8000 m<sup>2</sup>, lies 5 m higher on average than the surrounding plain. As the circumstances surrounding the "rediscovery" of the site and its identification as the DK-I Area have already been described in detail<sup>1</sup> a brief summary will suffice here.

The MN Area was excavated in Dec. 1933 and between Jan. 14 and Feb. 6, 1934 by Q. M. Moneer and K. N. Puri, Custodian of the Mohenjo-Daro Museum.<sup>2</sup> The site overlaps a trial trench dug in 1923 (Trench D, Fig. 3), of which a few photographs have survived (Figs. 4, 5). Unfortunately neither drawings nor photographs of Moneer's excavations are known to exist<sup>3</sup>, and it is only thanks to Dr. Jansen that at least the handwritten field registers with the lists of finds made in the various excavated areas could be tracked down in the site museum.<sup>4</sup> However, although facilitating general statements on the existence of rooms with a particular function or belonging to a certain class, these registers do not enable the listed finds to be allocated to precise findspots, and thus the information they contain will remain strictly limited as long as sketches of the room numbering systems or other back-up documents fail to the turn up.

The first plans of the architecture of the Moneer Area were drawn up in 1950 by Sir Mortimer Wheeler as part

of his general map of Mohenjo-Daro (scale 1: 476) (Fig. 6). These plans are sources of irreplaceable value as the excavated brick structures relentlessly continue to crumble and the numerous reconstructions are rarely identifiable.

In 1979/80 the Moneer Area was first surveyed in detail and photographed in the course of the work of the Mohenjo-Daro Research Project. The so-called areas (enclosed by spaces such as streets, public squares or unexcavated ground), individual structural units and streets were classified according to a uniform system<sup>5</sup> and numbered (Fig. 7).

In the following years large-scale clearing was carried out with the kind permission of the Department of Archaeology and Museums, Pakistan, as a result of which the areas that had become obscured by wind-blown soil or vegetation, since they were excavated in the 1930's, could be partly restored to their original condition. Among the more noteworthy successes made possible by the clearing operation were the location of a number of street drains and the rediscovery of well preserved mud floors in House B I.

In the 1982 field season those areas which had only been superficially included in the reconstruction and preservation programme of the site were more thoroughly analysed and individual structures investigated in more detail.

In 1984 the two eastern portions, MN-C and -D, were likewise cleared, thus allowing the general plan of the MN Area to be completed by isometric and top views (Fig. 8).

The fact that the MN Area has remained more or less unpublished simply underlines its special position in the architectural analysis of Mohenjo-Daro. The area was particularly fortunate in being almost completely omitted (up to 1979) from the admittedly necessary reconstruction and preservation measures undertaken on a massive scale in Mohenjo-Daro, consequently its structural remains have suffered hardly any secondary alteration.

It is only due to the initiative of Dr. Jansen and the kind cooperation of the Department of Archaeology and Museums, Pakistan, that the restoration work could be brought to a halt in 1979 for the duration of the architectural documentation. Thus the entire areas MN-C and -D are still in their original excavated condition, about 70% of the MN-B Area has been untouched, whereas MN-A and -E have been almost completely renovated and are hence of little scientific value.

In the immediate vicinity of the MN structural remains is the craft manufacturing area investigated by the Italian IsMEO team with the cooperation of the Mohenjo-Daro Research Project. The surface distribution of artefacts and waste products from this manufacturing site extends right up to the eastern

limit of the MN excavated area. It will obviously be interesting to see what results a correlation of the architectural remains and the manufacturing site will bring. The major obstacle in the way of any interpretative study of the MN Area is the totally inadequate documentation of the excavations, particularly in view of the conventional working methods of prehistorians who largely determine classification systems and functions of structural units on the basis of observations made possible by excavation, or at least must rely heavily on the find inventories of individual compartments (Kilian 1984: 37; Heinrich 1982 and 1984).<sup>6</sup>

Without a record of the observations made during excavation it would be more or less impossible, for example, to classify individual compartments as "yards" (characterized by accumulations of rubble and domestic debris, traces of animal husbandry, varying ground structure).<sup>7</sup>

The same holds for statements regarding the chronological relationship between individual structures where clear architectural indications (such as jointly used connections to the street drain system, clearly visible extensions incorporating walls shared with neighbours etc.) are absent.

The interpretation of the structural remains of the MN Area closely follows the theoretical guidelines outlined in the first volume of this series<sup>8</sup> which were adapted to meet the particular requirements of the architecture of Mohenjo-Daro by Dr. Jansen and the Research Project.

The more or less original condition of the excavated structures means that a more exhaustive study can be made of, for instance, the most pressing topic for analysis — the three-dimensional growth patterns of selected structures. This analysis can be expected to produce more reliable information than the investigation of radically restored buildings in the other excavated areas of the site.

As an illustration of the possibilities of such an analysis, an account is given here of a single house unit in the Moneer Area for which plenty of supporting evidence is available.

#### Moneer Area, House B II

The outside walls of House B II (Fig. 9) are bounded on the south by Street E-W-5, on the east by House B I<sub>3</sub>, on the west by House B IV and on the north by House B III (Fig. 8).

At the time of its maximum extent this house covered a total area of 159.60 sqm, of which 51.44 sqm (= 32.23%) are taken up with structural elements (walls, stairs, entrances and passageways) (Fig. 10).<sup>9</sup>

Possible access routes:

- a later blocked-up, narrow passage in the north-western corner (Room 1), leading into a kind of courtyard formed by Houses B IV, B IV<sub>1</sub>, and B III;<sup>10</sup>
- a small passage at the south-western corner of House B I<sub>3</sub> possibly gave access from Street E-W-5 via Room 13;
- a direct entrance into Room 11 from the south, apparently was the principal access route.

The oldest excavated construction phase of this house unit has survived merely as a section of the southern façade a couple of bricks high which was evened up in the following construction phase by means of a levelling layer and used as the foundation for the outside wall of the newer building (Fig. 11). Today this façade is over 2 m high and preserves a number of structural bits of chronological evidence such as blocked-up entrances, levelling layers, or stepped transitions from one wall section to the next above it. The structure built in the following phase (Fig. 12) formed an almost perfect square 11 x 10.5 m in area with a larger central compartment (courtyard?), Room 6, in the north and a smaller one, Room 5 (6 sqm), in the west with a staircase adjoining it on the south which leads upwards from the central room.

This combination of two rooms and a staircase repeats itself not only in a later extension to House B II but is also found in other house units in the Moneer Area, such as A I, A IIa and IIb, B IV and VI<sub>1</sub>, and E I and, less certainly, B V and A XI (the latter presumably incorrectly reconstructed). Obviously this division of space represented some kind of standard element in the groundplans of the house units. As the house types diagnosed by A. Sarcina<sup>11</sup> show, this planning norm is not restricted to the Moneer Area alone. Although her classification of a number of buildings according to type groups can no longer be justified it is worth noting that, of her 112 classified house units 10% have this room — staircase combination in their groundplans<sup>12</sup> (Fig. 13).

It is by no means clear where the stairs led up to; if they led up to the roof or to an upper storey then there would have to have been either a movable or a vanished continuation of the staircase, possibly a wooden construction, or else a ladder. The preserved groundplan of this second construction phase also comprises a long, narrow room in the north-eastern corner of the house which was presumably entered from the west only, as the main doorway to the house (subsequently blocked up) is still recognisable in the southern façade.

It was not possible to determine the layout of the southern rooms in this house unit due to the fact that the floor level in this section is about one metre higher than that of the other rooms. The structures under discussion would thus appear to belong to a later phase in which the building was extended upwards. But prior to this a three-part extension was added on the west (Phase 3), repeating the layout of the adjoining

rooms to the south (*Fig. 14*) — a smaller room in the north-west corner with a staircase immediately south of it, a large central room and a third chamber in the north-east. In this north-east chamber, which contains a fired-brick platform (*Fig. 15*), a large pottery sherd bearing a fragmentary animal figure was brought to light when the floor was cleaned. A similar find has been reported from Street E-W-5 immediately below the effluent outlet of the sanitary installations at the south side of House B IV (*Fig. 16*). The vessel fragment found in House B II may be related to the sanitary installations in House B I<sub>3</sub> and the platform may have been part of the passageway between the two neighbouring Houses B I<sub>3</sub> and B II.

However, there is still a question mark hanging over the vessel fragment found in House B II, Room 3. Wheeler's 1950 plan shows this room divided into three compartments (*Fig. 17*). Yet House B II is situated in a section of the excavated area where reconstruction measures are restricted to the removal of scattered pieces of masonry prior to the insertion of a horizontal damp-proofing course. Either Wheeler's otherwise exactly drafted plan is incorrect at this point, or a few courses of bricks were built up subsequent to the excavation (and later removed) as has frequently been the case all over the site. If such secondary building did take place it would naturally detract from the archaeological credibility of the vessel fragment with animal decoration found in the same context.

Leaving aside the question of the archaeological significance of the subdivision of Room 3, the fact remains that the annexe (Rooms 1-3) blocked up the passageway between Houses B I<sub>3</sub> and B II. It is not clear whether the passageway between Rooms 2 and 6 existed as such, i.e. with the main access at the south, or whether the building was entered at the north-western corner which would not have been blocked up until the entrance to Room 6 was opened.

The following construction phase saw the walls raised higher using parts of the old masonry as a base (*Fig. 18*). This can be seen in the overlaps between the masonry sections built on top of one another in Rooms 5 and 6, in the blocking up of the old entrance and the building of at least one new entrance at a higher level.

By this phase the building had attained its present ascertainable area and proportion. It seems most likely that the main access was from the south; it is no longer possible to decide whether the passage in Room 1 was blocked up by this final phase or not.

The wall built in this construction phase takes up most of the southern façade of the house and still stands to a height of up to 18 brick courses. The blocked-up doorways are still recognizable from the room behind (Room 11), whose excavated floor is roughly level with the thresholds. An accurately laid brick bathing platform is still in place at the same level in Room 11a, drained via a horizontal outlet in the façade.

Immediately beside this is a second sanitary outlet, a sloping effluent chute. Clearing operations in the street beneath these installations brought nothing more informative to light than a couple of bricks (*Fig. 19*). As the search for a possible drain connection of a soakpit cannot be properly carried out without an excavation permit this will have to remain a future priority.

The threshold levels inside the building are slightly lower than those of the two doorways opening directly onto the street. Four interior thresholds (between Rooms 11-9 / 54.30 m above m.s.l.; 9-8 / 54.25 m; 9-6 / 54.35 m; 6-5 / 54.34 m) are still identifiable at their original levels. Other structural features corresponding to these threshold levels include the masonry overlaps in the walls of Room 5 and 6, the threshold of the outside doorway of Room 1, the bottom of the base of the staircase in the south-west of Room 6, and the foundation of the platform and the vessel fragment unearthed in Room 3.

Besides the two staircases in House B II already referred to there is another in Room 11 adjoining a washing or bathing platform. The staircase-platform combination is not merely coincidental, it crops up again and again, e.g. in the neighbouring house units B IV (Rooms 11 and 11a) and BV<sub>1</sub> (Room 13).

Only two indications of the final construction phase have been preserved, i.e. the blocked-up entrances in the southern façade and the remains of a second bathing platform south of Room 13 (*Fig. 20*), the latter just recognizable from its foundations consisting of sherds and overfired lumps of clay. Effluent was presumably drained via the passageway between Houses B I<sub>3</sub> and B II.

The good state of preservation of the structures as excavated has made it possible to analyse not only the sequence of the various construction measures carried out on the house itself but also the chronological relationship of the entire unit to the neighbouring structures, admittedly a complex undertaking. The general direction of expansion within the MN-B Area is east-west (*Fig. 21*), as has already been noted elsewhere.<sup>13</sup> Although the relationship of the initial B II structure to the large B I complex cannot be determined due to the lack of excavation records, it may be presumed that House B II was built up against the boundary of B I rather than vice versa. House B IV is more recent than the northern extension of House B II as it partly makes use of the latter's outer wall, or at least acknowledges its existence. — The façades of Houses B II and B IV (*Fig. 22*) correspond to this postulated construction sequence.

At a level of roughly 54 m there is an irregularity in the masonry of the southern façade of the sanitation tract of House B IV which corresponds to both the upper limit of the Phase 2 brickwork of House B II and the threshold level of the lowest doorway (53.97 m), subsequently blocked up. This plane would appear to indicate the street level of the period. Any renovation of

the house would have meant replacing those bricks most affected by water splashing off the street, i.e. knocking down the wall as far as street level and rebuilding it using the underground portion as a foundation.

It has frequently happened that the new wall did not exactly follow the course of the old, resulting in the indented overlapping already referred to (Rooms 5 and 6) or, as in Phase 3, in the slight misalignment of the façade towards the east. This can still be seen in the double joint in the south-west corner adjoining House B IV, which by then had obviously not yet attained its final form. The rebuilding of House B IV then produced the puzzling T-shaped irregularity still visible at the joint between the north-east corner of the sanitation tract and the south-west corner of House B II. The builders obviously intended both to make use of the existing substructure as the foundation for the new masonry and also to close the gap between the two houses, and the structural result was this awkward joint.

Also more recent than House B II is House B III, about which little more can be said due to the shallow excavation at this point. In a similar way the structural units B V<sub>1</sub>, B V<sub>2</sub> and B VI<sub>2</sub> then followed in sequence, although the position as regards B VI<sub>2</sub> is by no means clear due to an unexplained double wall.

To sum up then, the description of even such a coherent structural unit as House B II must necessarily appear generalized, yet this fact in itself underlines the need for further research. The available documentation and data on the Moneer Area have enabled us to lay the mere foundations of a proper investigation of this neglected site, which more than deserves all the scientific attention it will hopefully receive.

## Footnotes

- 1 M. Jansen 1984a: 139; 1984b
- 2 ARASI 1930-34: 51, 72; *ibid.* 1936-37: 41
- 3 ARASI 1930-34: 51
- 4 Jansen et al. 1984c: 54
- 5 Jansen 1984a: 141-143
- 6 This is equally true of the representatives of the ethnographically orientated "modern" or "behavioural" archaeology (Eggert 1978; Jansen 1984c: 39, note 1) and the younger of the "comparative" prehistorians (see the contributions in: Papenfuß, D./Strocka, V.M. 1982)
- 7 Neither could classification schemes such as those devised by Robert Koldewey, Walter Andrae or Ernst Heinrich (historical survey on research and bibliography in: Heinrich, E. 1982: 1) be applied (as, for example, in this case it is impossible to differentiate between the layouts of a so-called "Mittelsaalhaus", i.e. a house with a roofed-in central hall, and a "Hürdenhaus", i.e. a house with a central courtyard)
- 8 Jansen 1984c: 39-41
- 9 Floorspace of a room in sqm, proportion EW/NS = relation of EW to NS extension of a room, prop absol. = absolute proportions of a room; quality I = room with opening to public space, II = transitroom, III = end room
- 10 Although the character of this court is questioned by the drawings of Wheeler, as obviously here some structures are discernable.
- 11 Sarcina 1978-79: Pl. V XII
- 12 *ibid.*: 169, Pl. XVI-XXXIX, i.e. 4 out of 42 "red" and 9 out of 58 "yellow types"
- 13 Jansen 1984a: 146

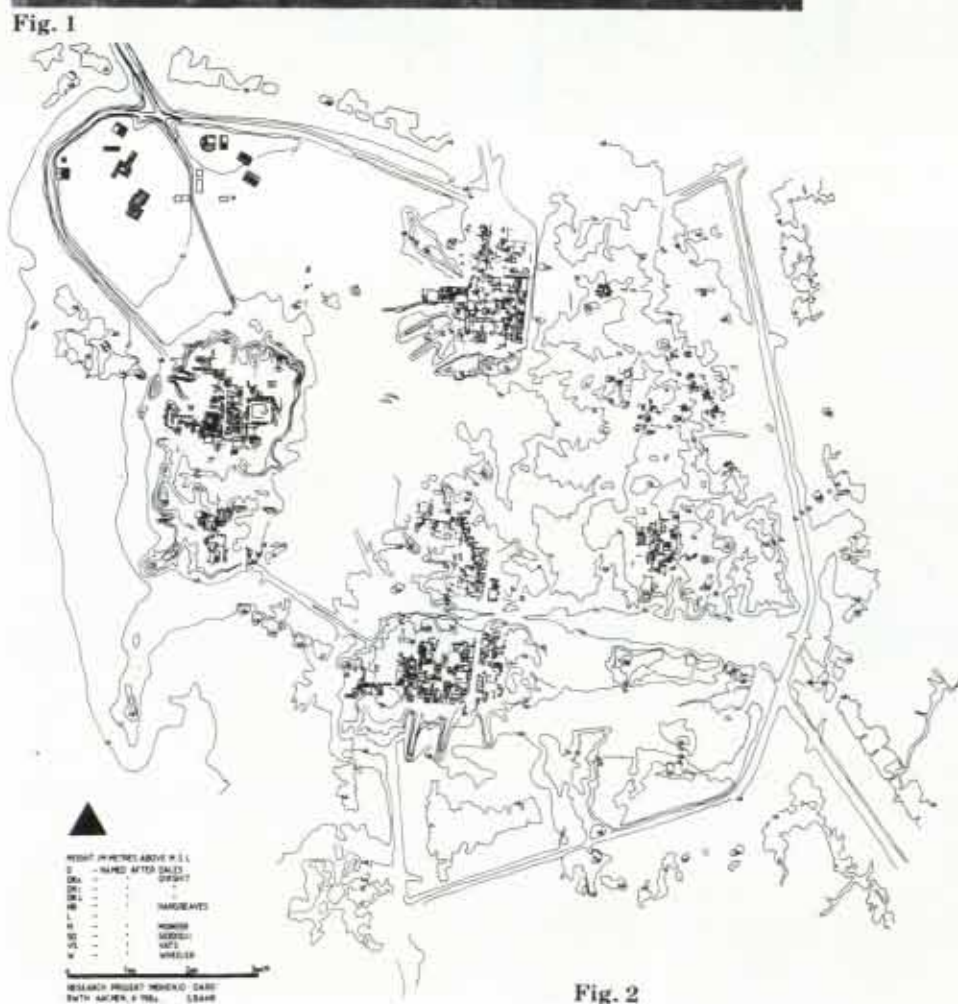
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**Fig. 1** Mohenjo-Daro, aerial view of Moneer Area.

**Fig. 2** Mohenjo-Daro, map of the site indicating the excavated areas.



**Fig. 2**



**Fig. 3** Mohenjo-Daro, excavation plan 1921-1982.

**Fig. 4** Mohenjo-Daro, trench DK-D east, later Moneer Area, as documented in Sind Volume IV 1924-25, 6568.

**Fig. 5** Mohenjo-Daro, trench DK-D east, later Moneer Area, as documented in Sind Volume IV 1924-25, 6567. Southern trench from north-east.

**Fig. 3**

**Fig. 4**



**Fig. 5**



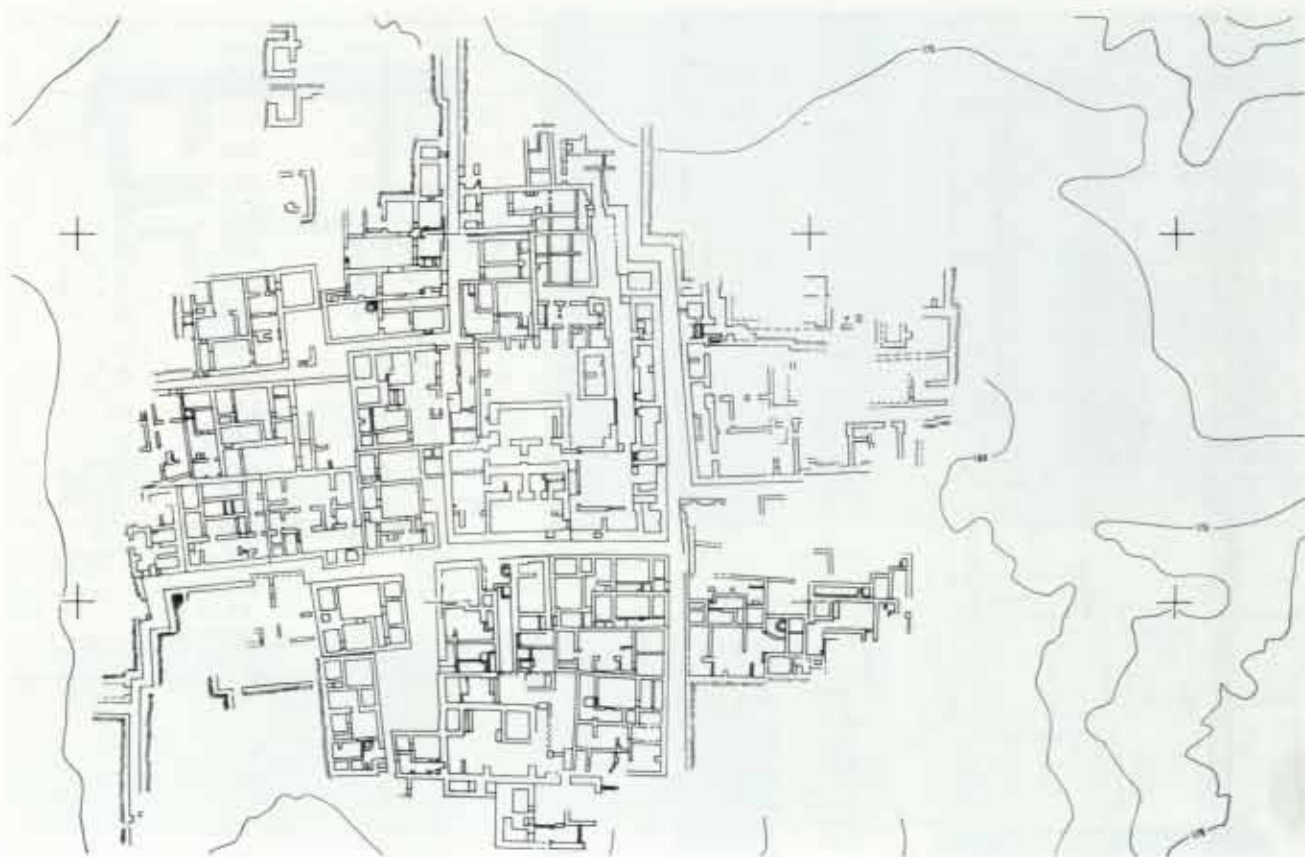


Fig. 6

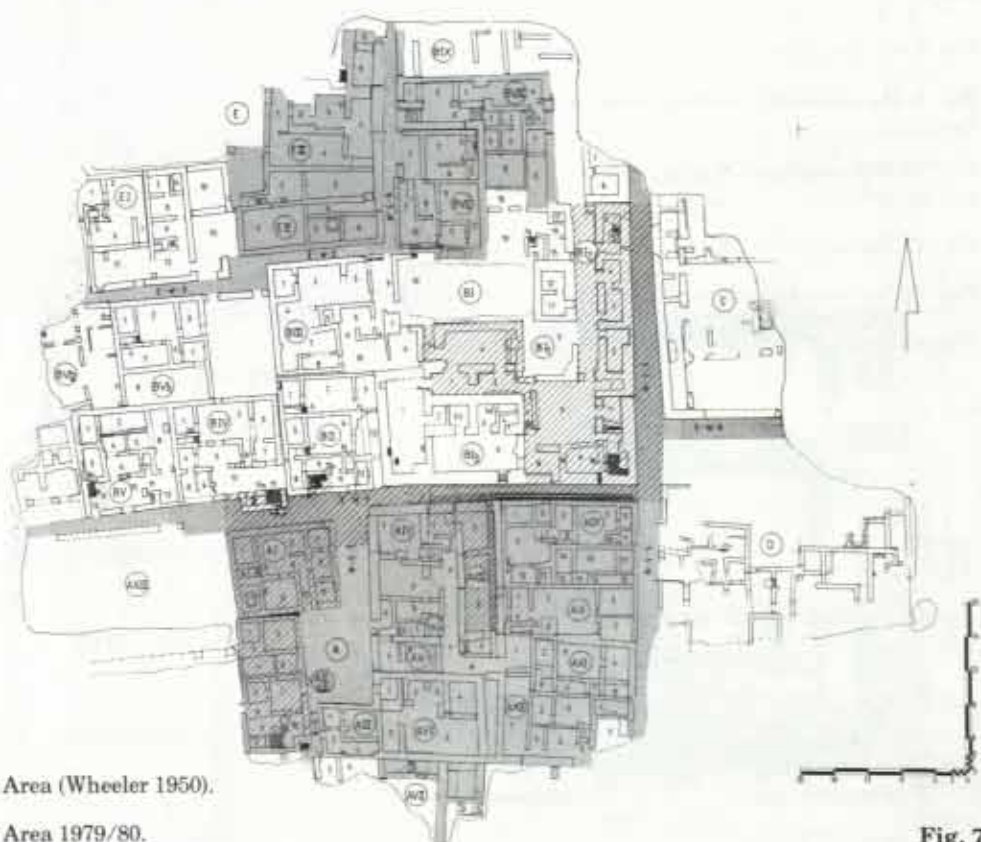


Fig. 6 Mohenjo-Daro, Moneer Area (Wheeler 1950).

Fig. 7 Mohenjo-Daro, Moneer Area 1979/80.

Fig. 7

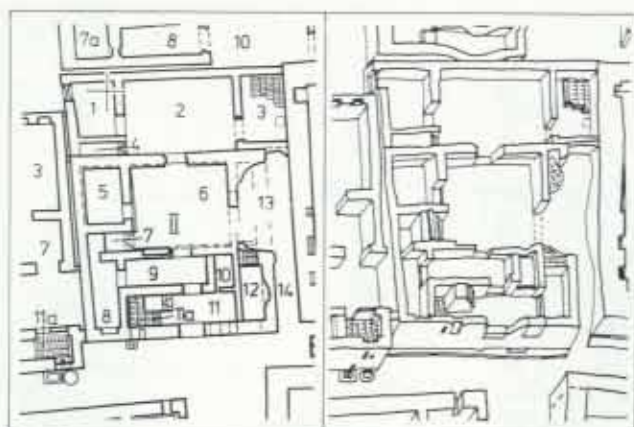


Fig. 8

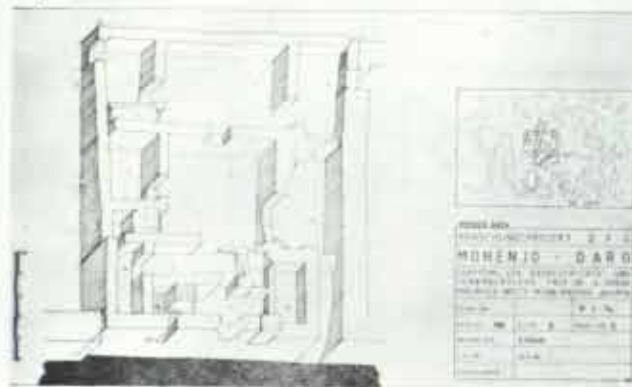


Fig. 9

Fig. 8 Mohenjo-Daro, Moneer Area 1985 (House B II)

Fig. 9 Mohenjo-Daro, Moneer Area House B II, isometrical view.

Fig. 10 Mohenjo-Daro, Moneer Area House B II, room space and proportions.

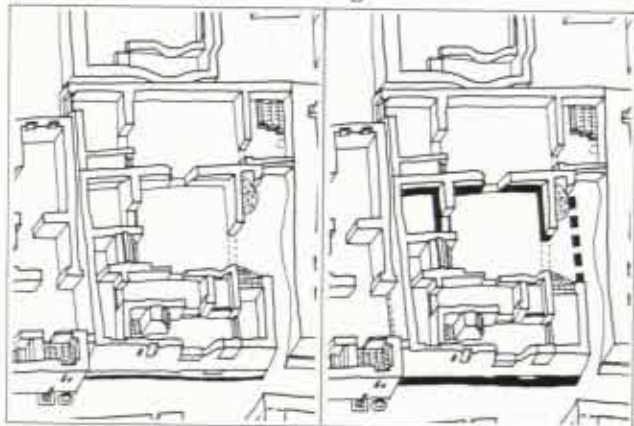
Fig. 11 Mohenjo-Daro, Moneer Area House B II, phase 1.

Fig. 12 Mohenjo-Daro, Moneer Area House II, phase 2.

Fig. 13 Mohenjo-Daro, house-types (*Sarcina* 1978/79: Pl. XII).

Fig. 11

Fig. 12



Room no.	space m <sup>2</sup>	prop. EW/NS	prop. absol.	quality
1	6.60	0.73	0.73	III (I)
2	23.20	1.45	0.69	II
3	7.92	0.61	0.61	III
4	1.33	2.71	0.37	III
5	6.00	0.67	0.67	III
6	22.44	1.16	0.86	II
7	0.86	0.86	0.86	III
8	4.84	0.40	0.40	II
9	6.02	3.07	0.33	II
10	1.46	0.51	0.51	II
11	9.12	3.56	0.28	I
12	3.36	0.43	0.43	III
13	4.20	0.24	0.24	I
14	10.80	0.13	0.13	I
total space			159.60	m <sup>2</sup>
effective space			107.19	m <sup>2</sup>
constructional space			51.44	m <sup>2</sup>
% of total space			32.23	%
proportion in relation to total space			0.32	

Fig. 10

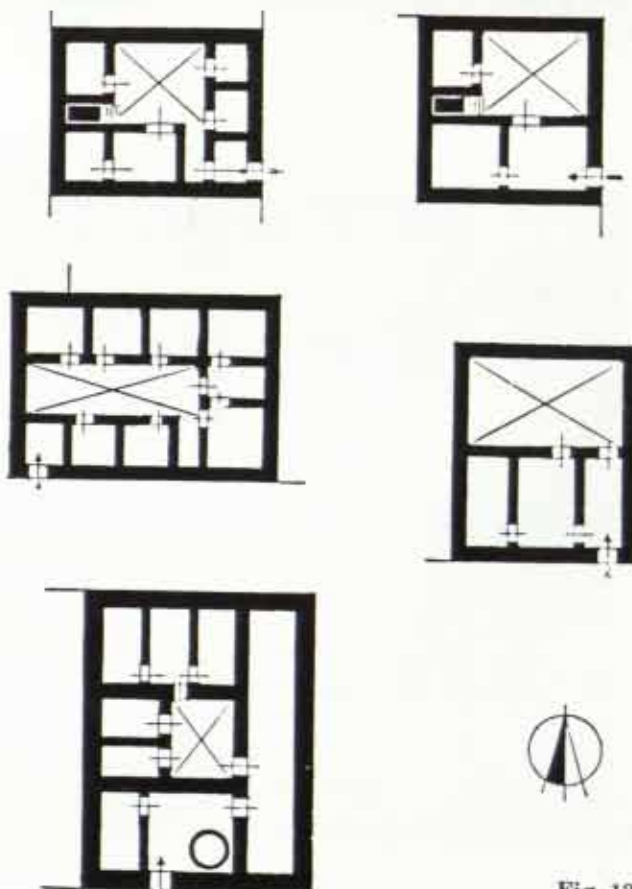


Fig. 13

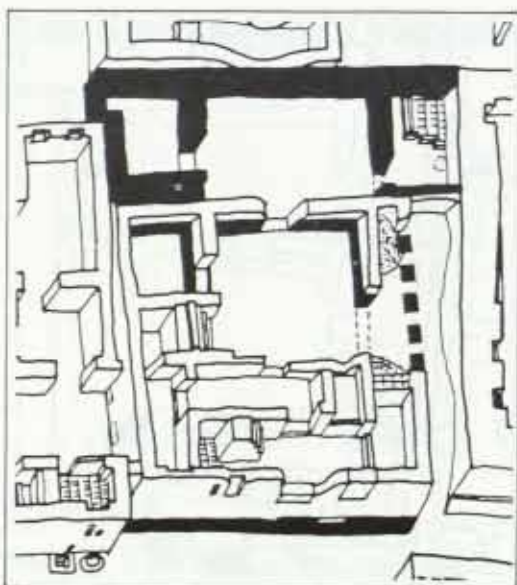


Fig. 14



Fig. 15



Fig. 16

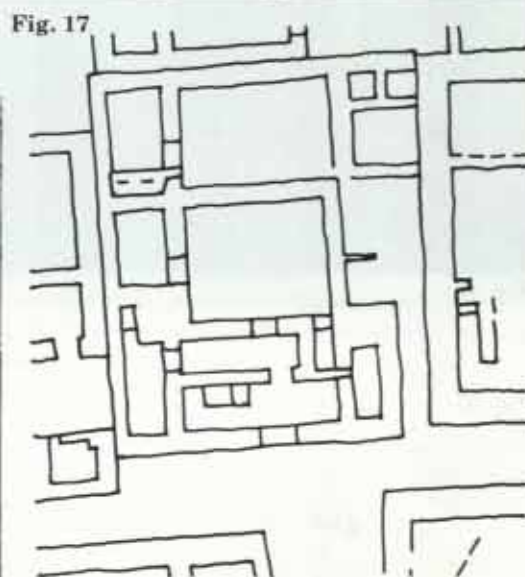


Fig. 17

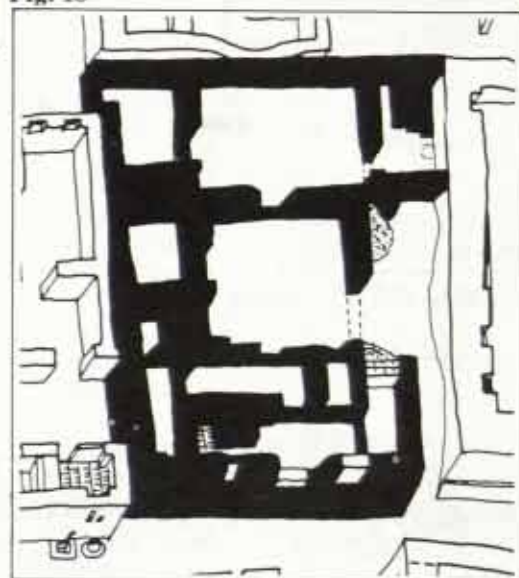


Fig. 14 Mohenjo-Daro, Moneer Area House B II, phase 3.

Fig. 15 Mohenjo-Daro, Moneer Area House B II, brick platform.

Fig. 16 Mohenjo-Daro, Moneer Area Street E-W-5 south of House VI, Room 11.

Fig. 17 Mohenjo-Daro, Moneer Area House B II (Wheeler 1950).

Fig. 18 Mohenjo-Daro, Moneer Area House B II, phase 4.



Fig. 19

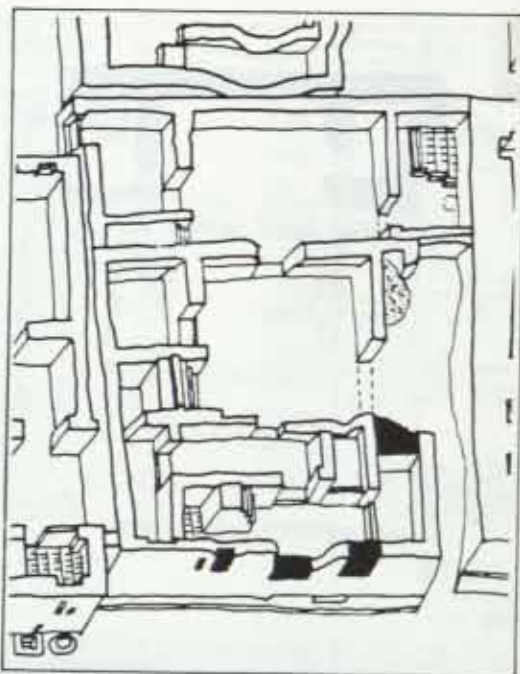


Fig. 20

Fig. 21

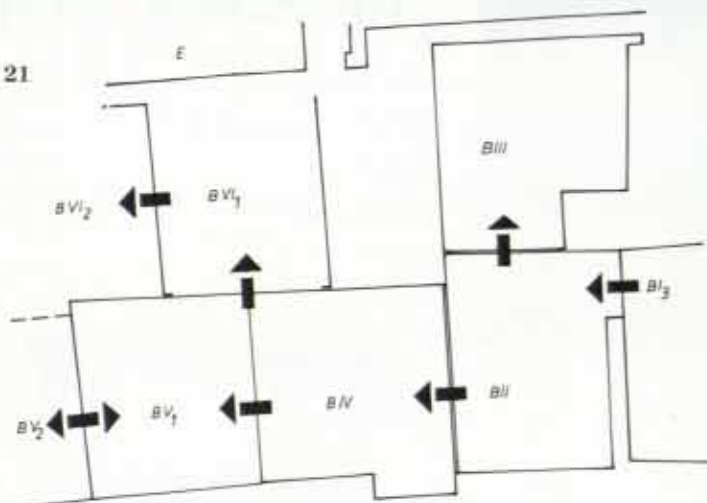


Fig. 22

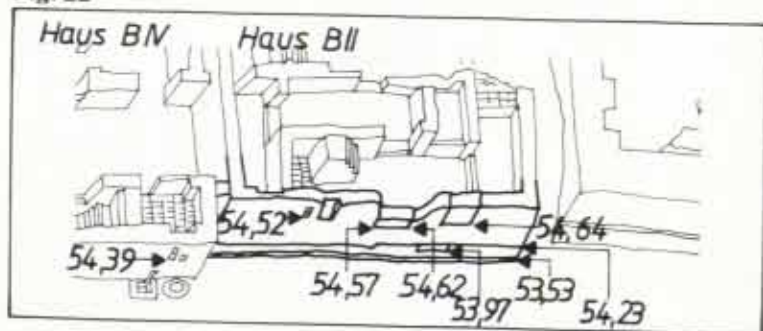


Fig. 19 Mohenjo-Daro, Moneer Area House B II, southern façade of Room 11a in Street E-W-5.

Fig. 20 Mohenjo-Daro, Moneer Area House B II, phase 5.

Fig. 21 Mohenjo-Daro, Moneer-B Area, direction of architectural expansion.

Fig. 22 Mohenjo-Daro, Moneer Area, façades of Houses B II and B IV.

# Axis Systems and Orientation at Mohenjo-Daro

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Bonn

## 1. Introduction

The aim of the German Research Project "Mohenjo-Daro" was to conduct a thorough structural analysis of the city of Mohenjo-Daro, the emphasis not being restricted to architectural features only, but extending also to fundamental aspects of the construction of the town. These included the question of a planning concept behind the city layout: are there any definable routes through it and, if so, is there any relationship between them and the cardinal points of the compass?

Previous publications on the urban structure of Mohenjo-Daro showed a grid-like street pattern (Diez 1964: Fig. 1). Other authors such as Mumford (1963) saw in this pattern a precursor of Hippodamian town-planning (Piraeus) and the checkerboard layout of Roman towns. But it is doubtful whether such a grid reconstruction of the street system reflects the facts. Very few of the thoroughfares shown in the published plan are based on the evidence of excavations (solid lines), most of them are hypothetical reconstructions (broken lines). Even where topographical features would appear to indicate the continuation of certain axes, there is no factual justification for linking up street sections to form long straight thoroughfares. Furthermore the plan is based on the tacit understanding that the entire site was settled at the same time. Therefore it seems pertinent to investigate the layout and orientation of the street axes of Mohenjo-Daro in more detail.

A possible layout reconstruction shall be considered under astronomical aspects and an attempt made to answer the question whether artificial or natural landmarks in connection with the rising and setting of certain celestial bodies may have been used as a calendar.

E. Macla (1984) partly based his astronomical explanation model for the ringstones as calendar stones on the observation that the alluvial plane of the Indus lacked a physical basis for a natural calendar.<sup>1</sup> However, this statement is not altogether true, at least not for some hours of the day.

## 2. Axis Systems at Mohenjo-Daro

Regarding the examination of the axis systems, the topographical maps published so far are not sufficiently reliable because the various excavated areas were not surveyed according to a uniform system of coordinates and the geodetic origin of the indicated cardinal points is not given.

It was only during the 1979/80 field season that more precise preparations for such an examination could be made:

- a triangulation net of fixed points was marked out over the entire site covering all the excavated areas;
- the coordinate axes were carefully orientated according to astronomical calculations.

This grid served as the basis for a new survey of the excavated areas to the scale of 1:200 and for a general topographical plan drafted from aerial photographs to the scale of 1:1000.

Generally speaking, the word "axis" in an urban context refers to the connecting line between two points of an architectural unit such as a façade, borders of a street, a canal or also the interior access system of a house.

The following scheme is limited to:

- general access axes in the excavated areas;
- strikingly long topographical depressions which may indicate buried streets.

### Axes in the Excavated Areas

Area	Axis	Deviation <sup>2</sup>
DK-G South	First Street	7.2
	Central Street	4.5
DK-A	Drain	5.5
DK-G North	West Street	5.2
VS-A	First Street	10.2
	Lane One	10.3
	Lane Two	9.5
HR	First Street	8.3
	Third Street	3.9
	Southern Part	
SD	Main Street	4.4
	Granary	5.5
	Great Bath West	5.3
	Divinity Street	5.8
	Stupa	5.5
DK-B/C	North-South Street	+ 5.8
Moneer	NS 5	- 0.4
	NS 6	- 0.1

### Topographical Axes

Area	No.	Length	Deviation (gon)
E of Moneer	1	300 m	9.0
W of Moneer	2	500 m	9.6
First Street HR and VS	3	560 m	11.0
Street axis in Dales	4	240 m	10.1
E-W depression	5	1000 m	9.8
N-S depression between VS and Moneer	6	250 m	0.1
N-S 5 axis in Moneer	7	400 m	0.3

Due to the uncertainty of the natural axes and the error margin of opisometrical readings there is a possible divergence of  $\pm 1^{\text{gon}}$ .

If we transfer these axes onto the topographical map we find the following structures (Fig. 11):

- the axes of the main access routes in the areas SD, L, HR, VS, Dales, DK-B+G show a divergence of  $7-10^{\text{gon}}$  towards East (Fig. 14);
- the topographical axes 6 and 7 and the Moneer and DK-C axes are orientated exactly towards the cardinal points;
- the North-South axis in the Moneer area continues southwards through the East-West depression (Fig. 13);
- the street axis DK-B continues right through to the east of the HR-area;
- the street axis of the Dales area is clearly discernible through brickwork that emerges on the surface 300 m south of it (Fig. 16);
- the topographical axes which run parallel to the HR street axis to the east and west of it are about 190 m apart from one another.

Thus we can define two different axis systems in Mohenjo-Daro:

system 1 is characterized by a noticeable shift in orientation of ca.  $8^{\text{gon}}$  clockwise, rectangular crossings of the axes and partly identical distances between the latter. System 2 is characterized by an exact orientation to the cardinal points but does not occur as often as system 1.

The ability to draw a right angle which is obvious in the system of axes and many of the ground plans of the houses is not apparent to the Great Bath (Fig. 2).

For the divergence of system 1 from the cardinal points several possible explanations can be considered:

- no great importance was attached to the exact orientation of the axes but whatever orientation happened to be chosen initially it was subsequently followed;
- the orientation had some relevance, but it was technically impossible to take more exact measurements. It cannot be reconstructed which orientation techniques were used;<sup>3</sup>
- in 2000 B.C. the star nearest the North Pole, the North Star, was Thuban of the Draco constellation.

Its distance from the celestial pole measured — depending on the period — 1 to  $3^{\text{gon}}$ . Consequently it is possible that an orientation towards this star was the cause of the divergence noted;

- the axes were orientated via an East-West line towards the rising or setting points of a star or a planet. A fixed star would be more probable because it does not change its point of setting over long periods;
- the divergence is due to unknown religious or mythological reasons.

### 3. Axis Systems at other Sites

This orientation of architectural axes to the cardinal points with slight divergences is not only observable in Mohenjo-Daro, other settlements of the Harappan culture also show similar orientation patterns.

Site	Axis	Divergence from North in gon
Harappa	Citadel	0
	Streets	- 11 to + 6
Surkotada	Town wall	- 16
Lothal	"Dock" wall	+ 5,5
	Street 1	- 4,4
Suktagen Dor	Surrounding wall	- 2
Balakot	West Lane	+ 3,3
	East Lane	- 1
Kalibangan 2	Surrounding wall E	0
	Exterior wall W	- 2
	Main Street	- 13

The orientation readings were taken from Jansen 1979.

All the settlements taken into account tend to show the same pattern: an approximate general orientation of important axes towards the cardinal points with slight divergences of several gon.

We cannot make statements regarding the orientations of other sites from the data available, as their definition of North and the degree of precision reached in calculating it is unknown. Especially the use of magnetic compasses and the failure to allow for declination could lead to major mistakes.

#### 4. The Horizon Calendar

If the orientation of architectural axes in Mohenjo-Daro really does have an intrinsic meaning and function, it would be most likely that of a calendar. We know from other contemporary cultures that their buildings were designed with a parallel use as calendars in mind. The rising and setting of celestial bodies in line with certain axes served as fixed points of the year (as, for example, in the case of the Egyptian pyramids, Stonehenge, Carnac). Sometimes artificial axes (rows of standing stones) were combined with natural landmarks on the horizon (Krupp 1980).

At first glance it seems improbable that the alluvial flood plain of the Indus river could yield any natural landmarks in the region around Mohenjo-Daro. In addition, visibility is limited to a few kilometers during the day due to the dusty haze.

But one hour before daybreak the impressive profile of the Kirthar range 100 km away appears clearly on the horizon. The peaks and valleys of this silhouette offer excellent fixed points which allow the points of setting of celestial bodies to be assimilated with a horizon calendar.

In order to examine the possible function of the Western horizon as a calendar, the azimuths of prominent points of this mountain profile were measured and a photographic recording sequence of the horizon was made, during the 1980/81 field season.

##### 4.1. Periodic Changes in Astronomical Phenomena

Today's astronomical constellations cannot be taken as the basis for an investigation into the possible calendar function of the horizon in antiquity.

Visibility, rising and setting points of the stars are subject to constant change. The astronomical data of the planets and the moon change most rapidly. Their historical positions can only be reconstructed for a precise point in time, not for a period. As the complete period from 2500 up to 1500 B.C. is relevant for our investigation, only the effects of the periodic change in astronomical data of the sun and fixed stars will be taken into account.

This change is determined by the following factors:

- rotation of the Earth = movement around its own axis
- revolution of the Earth = movement around the Sun
- precession = movement of the rotation axis of the Earth on the envelope of a cone
- change of obliquity of the ecliptic

##### Rotation and Revolution

The movement of the Earth around the Sun together with its own rotation causes the non-circumpolar<sup>1</sup> constellations to shift their points of rising and setting in the course of a year.

Consequently some of them are not visible for part of the year, as they then rise and set during the day. Thus we are familiar with typical seasonal constellations like Orion in winter and Sagittarius in summer.

The reason for these phenomena is that at a certain time of the year the Earth is situated between the Sun and the constellation (which is visible at night), whereas half a year later the Sun stands between the constellation and the Earth and the star would be visible only in daytime.

On its orbit around the Sun the equator of the Earth is inclined against its orbital plane; today the obliquity of the ecliptic measures  $23.44^\circ$ . Visible consequence of this obliquity on Earth is the seasonal<sup>5</sup> change of the zenith of the Sun, the varying length of the days and the shifting points of sunset and sunrise.

The angles ( $d$ ) between the setting points at the solstices depend on the geographical latitude; they are only minimal at the equator with the double obliquity of the Earth ( $d=47^\circ$ ) and not definable in regions north of the Arctic Circle, where the Sun does not rise in winter nor set in summer.

Rising and setting of the fixed stars are not influenced by the obliquity of the ecliptic. Each of the non-circumpolar stars always touches the horizon at the same point.

##### Precession

The dynamics of the Earth closely resemble a child's spinning top. The effect of the gravitation of the Sun is that certain forces strive to raise up the oblique axis of the earth into a right angle. Just like a top, which is spun from outside and starts to wobble, the pole axis forms an envelope of a cone and the celestial pole forms a circle. The period of precession, i.e. the time of one orbit describing the cone envelope, amounts to 25.800 years.

The movements in the Earth-Sun- and Moon system are hardly influenced by precession, but the course and the visibility of the fixed stars are very much affected.

## Sun

While the Sun's visibility and her points of rising and setting are constant the beginning of the seasons shifts in accordance with the position of the Earth on its orbit around the Sun.

Nowadays the summer solstice occurs 10 days after the Earth has passed through its orbital point most distant from the Sun (Aphel). But 13.000 years ago the Earth passed through its orbital point closest to the Sun (Perihel) at the beginning of summer.

As greater proximity to the Sun implies a higher degree of energy radiation, the climatic seasonal extremes — discounting other factors — would have been much more intense 13.000 years ago.

## Fixed Stars

Precession largely determines the visibility of fixed stars. The extension of the rotation axis of the Earth into the celestial sphere, i.e. the celestial North Pole, describes a circle with a diameter of  $47^\circ$  in 26.000 years.

Thereby various stars approach the North Pole in turn and consequently become the North Star of the respective epoch. Today the brightest star from the Ursus Minor constellation is very close to the Pole; in 2500 B.C. its place was taken by the somewhat less bright star Thuban from the Draco constellation and in 11.000 B.C. by the bright star Wega from the Lyra constellation.

As a result of precession, circumpolar constellations shift gradually in relation to a fixed point. Stars become visible which otherwise remain below the horizon. The Southern Cross, today only visible from the southern hemisphere and in subtropical northern latitudes rose as far north as  $50^\circ$  latitude 10.000 years ago.

Precession changes the points of rising and setting of fixed stars on the horizon. The degree of shift is not constant and depends on the starting position of the relevant star.

## Azimuth of Setting Points

	2000 A.D. Declination (gon)	of star	2500 B.C. Declination (gon)	of star
Procyon	307,0	$5,2^\circ$	306,1	$4,5^\circ$
Andromeda	337,5	$29,1^\circ$	309,8	$7,5^\circ$
Cassiopeia	379,1	$56,5^\circ$	342,9	$33,2^\circ$

Extensive tables with the historical positions of the stars are to be found in *Baehr*.

## Shift in Ecliptic Obliquity

The angle formed by the rotation axis of the Earth with the path of its orbit around the Sun (obliquity of the ecliptic) changes slowly in the course of the centuries, reducing by  $0,1^\circ$  in 1000 years. Thus the precession of the celestial pole is actually not a closed circle but a spiral. The consequences of the changing obliquity of the ecliptic for the points of rising and setting of the fixed stars are minimal compared to the effects of precession.

Over longer periods of time, this changing angle has a noticeable effect on the points of sunset and sunrise at the solstices — they shift to the west.

In relation to the geographical position of Mohenjo-Daro, the setting point at the solstices shifted, due to the obliquity of the ecliptic, by  $0,6^\circ$  between 2500 B.C. and 2000 A.D.. This equals the apparent diameter of the Sun disc.

Finally it should be mentioned that atmospherical conditions also have a major influence on the visibility of celestial bodies. Close to the horizon a beam of light travels a longer distance through denser layers of air as it does close to the zenith.

This causes:

— REFRACTION, an apparent higher position of the star, as the beam of light is curved. While it has already set astronomically, its image is still visible above the horizon. (Fig. 8)

— EXTINCTION, the absorption of the energy radiation i.e. reduced brightness. The star is extinguished when it comes close to the horizon. At an altitude of  $10^\circ$  above the horizon the starlight is weaker by one magnitude ( $1^m$ ), at  $1^\circ$  by  $4^m$ .

As the eye is able to recognize stars down to a brightness of  $5^m$  to  $6^m$ , only the rising and setting of very bright stars (magnitude  $\leq 1^m$ ) is visible on the horizon.

For the sake of completeness it should be mentioned that yet other effects may alter the apparent movement of the stars, such as nutation, aberration, parallax and their own motion. But this applies only on such a minimal scale that it has no influence on the following reconstruction.

#### 4.2 Astronomic Reconstruction of the Course of Stars on the Western Horizon for the Period 2500—1500 B.C.

It may be concluded from the shifting astronomical parameters outlined in the preceding chapter that the changing obliquity of the ecliptic has a marked effect on the course of the Sun, whereas the course of the fixed stars is influenced by precession.<sup>6</sup>

##### Sun

The obliquity of the ecliptic in 2500 B.C. measured  $23.98^\circ$ , in 1500 B.C.  $23.86^\circ$  and today it measures  $23.44^\circ$ . The refraction taken into account the apparent course of the Sun at the solstices and the equinoxes is shown on the photograph of the horizon profile (Fig. 9). The point of setting at the winter solstice is remarkable; here the Sun disappears down a deep valley in the south-west, having taken its course along a steep slope. Fig. 15 shows the sunset on the 22<sup>nd</sup> of December 1982, to the left of it we see the course of the Sun at the winter solstice in 2500 B.C.

On the topographical map 1:500,000 (Fig. 10), the identification of these two valleys shows the following situation:

the most southern valley belongs to a mountain saddle, whereas the deep valley west of it is in fact the river gorge of the Gaij-Naij river crossing the Kirthar range. In 1938 settlements were discovered somewhat further to the east, which belong to the early Harappan period (Deva; McCown 1949).

This valley can be regarded as the starting point for a natural horizon calendar using the sunset as indicator. The strongly undulating mountain silhouette offers many orientation marks in the course of a year: a shallow depression at the equinoxes and yet another one at the summer solstice.

##### Fixed Stars

As was mentioned in Chapter 2, the architectural axes of Mohenjo-Daro show a slight divergence from the cardinal points of  $1^\circ$  to  $2^\circ$  clockwise.

This could be explained by the fact that they were orientated towards the setting point of a star. As the starlight close to the horizon is subject to extinction, it must have been a very bright star which set close to cardinal west. For the period under consideration (from 1500 to 2500 B.C.) there are only two fixed stars which meet these conditions:

Name	Constellation	Brightness	Setting Point from W to N (gon)	
			— 2500	— 1500
Procyon	Canis Minor	0. <sup>m</sup> 5	+ 5.4	+ 8.3
Aldebaran	Arietis	1. <sup>m</sup> 1	— 3.0	+ 3.8
	Pleiades	3. <sup>m</sup> 0	+ 2.4	+ 8.0

In Fig. 9 the courses of the three stars during the different centuries are indicated. The setting point of the star Aldebaran coincides with the divergence of Mohenjo-Daro's street axes for the period from 2000 to 1600 B.C.. At the same time the axis of the "Granary" pointed towards the setting point of Procyon.

Due to the reduced brightness, the setting of the Pleiades cannot be observed on the horizon. The Arabic astronomers called Aldebaran "*he who follows the Pleiades*". The Pleiades, the Seven Sisters, are the celestial manifestation of the mythical number seven.

Before all the facts given so far are accounted for in a reconstruction model, the essential observations can be summarized again briefly:

1. In Mohenjo-Daro, but also in other sites of the Harappan culture, a slight divergence of the architectural axes from the cardinal points can be detected.
2. The characteristics of the Kirthar range profile furnish the topographical preconditions for a horizon calendar.
3. Close to the mountain valley where the sun sets at the winter solstices, early Harappan settlements have been found.
4. In 2000 B.C., two very bright stars which could still be observed on the horizon set north of cardinal west. The street axes of Mohenjo-Daro are orientated towards the same direction.

These observations suggest the following theory: the site upon which Mohenjo-Daro was founded was selected because of its position on the Indus and the direction of the early Harappan settlement in the valley towards the rising point at the summer solstice. The horizon outline of the Kirthar range provided the conditions for establishing a natural calendar starting at the point of the winter solstice in the valley of their predecessors. The special importance of the number seven and its celestial manifestation may have influenced the orientation of the axes towards the Pleiades and the star Aldebaran, whose setting point could be observed on the horizon.

A consequence of such a reconstruction would be that the orientation of the architecture shifted in the course of the centuries; the system of orientation is also a dating system. In order to verify this theory, exact astronomical orientations would have to be calculated at other sites of the Harappan culture.

## Footnotes

- 1 "In Moenjo-daro, however the horizon is not broken by natural landmarks rising from the alluvial plane" (Maula, E. 1984: 161).
- 2 Deviation here means the relative orientation towards any of the cardinal points with a clockwise divergence, for example: 3.5 = North with a divergence of 3.5° towards East.
- 3 From other cultures the use of the so called Gnomon is known (i.e. a stick that casts a shadow). If cardinal North is not derived from the shortest length of the shadow but from the bisector of angles from corresponding shadow lengths both in the morning and in the afternoon, there is a high degree of exactness.
- 4 Circumpolar are those constellations which do not set below the horizon line. Circumpolarity is dependent on the geographical latitude; at the poles every constellation is circumpolar, at the equator none.
- 5 "Seasons" in this case is used in its normal sense. Obviously in Mohenjo-Daro the climatic-seasonal division of the year is different, see Jansen 1979: 60.
- 6 The courses of the planets are not reconstructed in this paper. Their reconstruction is theoretically possible (Ahnert 1961), but only for given dates due to their orbiting speed. With the courses of the planets coinciding with the plane of the Sun orbit (Venus 3.5°, Mars 2°, Jupiter 1°), they always set near the cardinal west, but this changes in the course of time.

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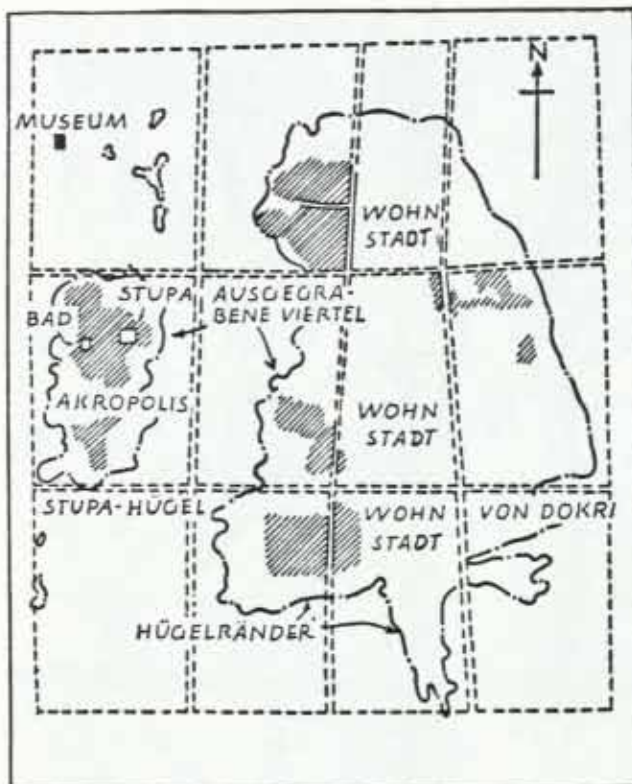


Fig. 1

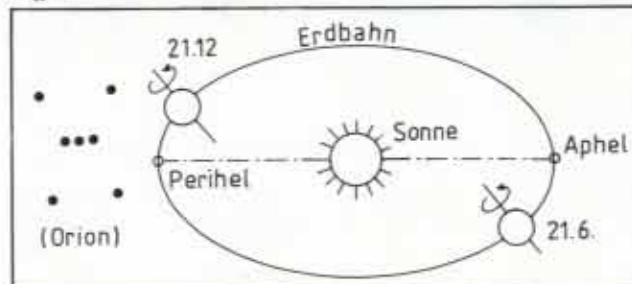


Fig. 3

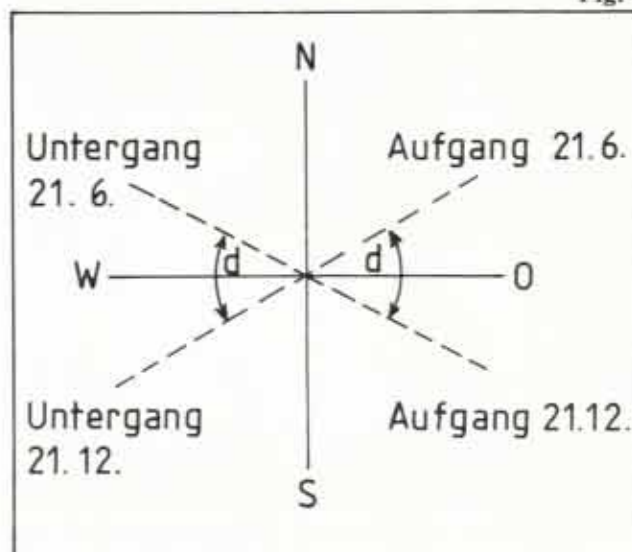


Fig. 4

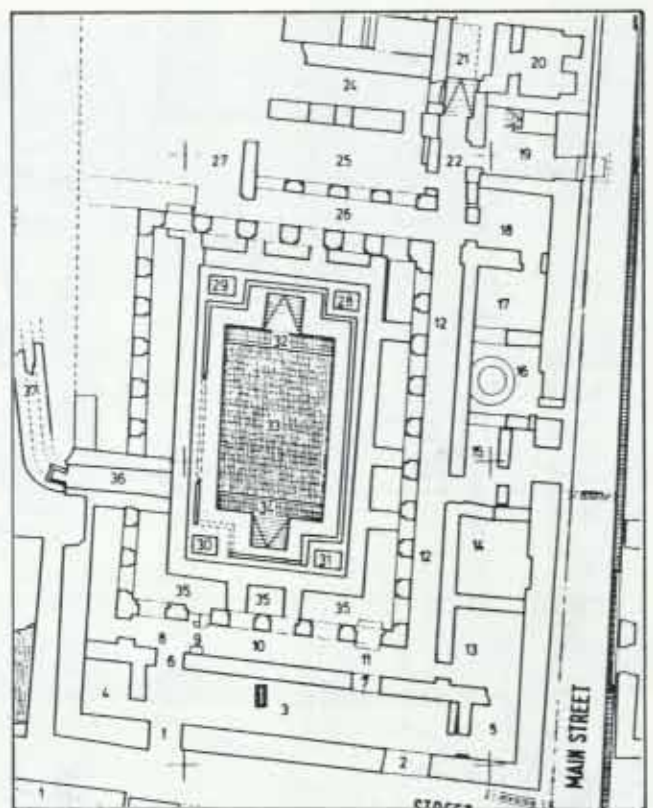


Fig. 2

Himmelsnordpol  
z. Zeit  $\propto$  Ursae minor

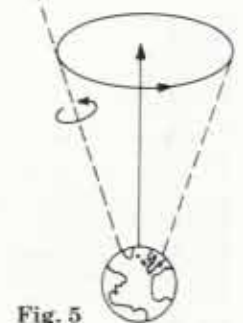


Fig. 5

Fig. 1 Hypothetical Street Pattern of Mohenjo-Daro (after Wheeler 1968)

Fig. 2 Mohenjo-Daro, Great Bath

Fig. 3 Periodic Visibility of Orion due to the Rotation of the Earth

Fig. 4 Difference between the Points of Rising and Setting of Fixed Stars at Summer and Winter Solstices (Angle "d")

Fig. 5 Precession of the Earth

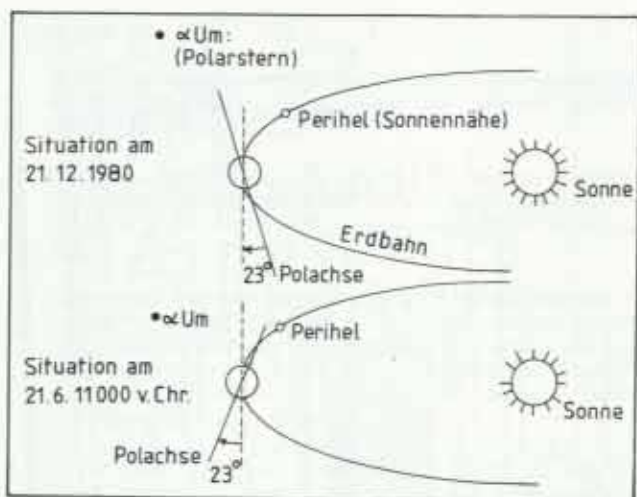


Fig. 6

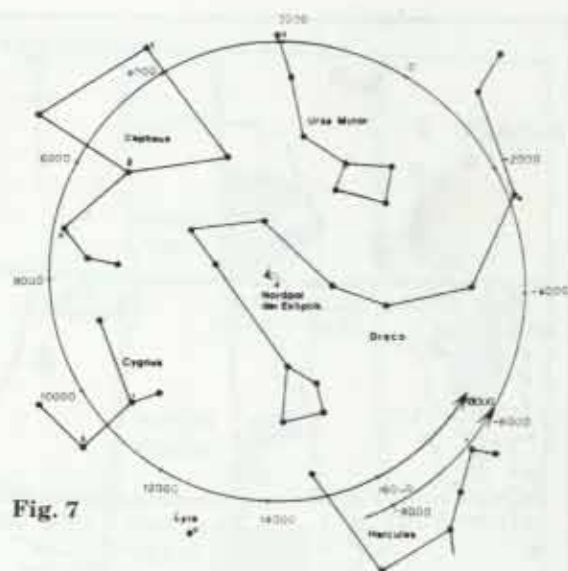


Fig. 7

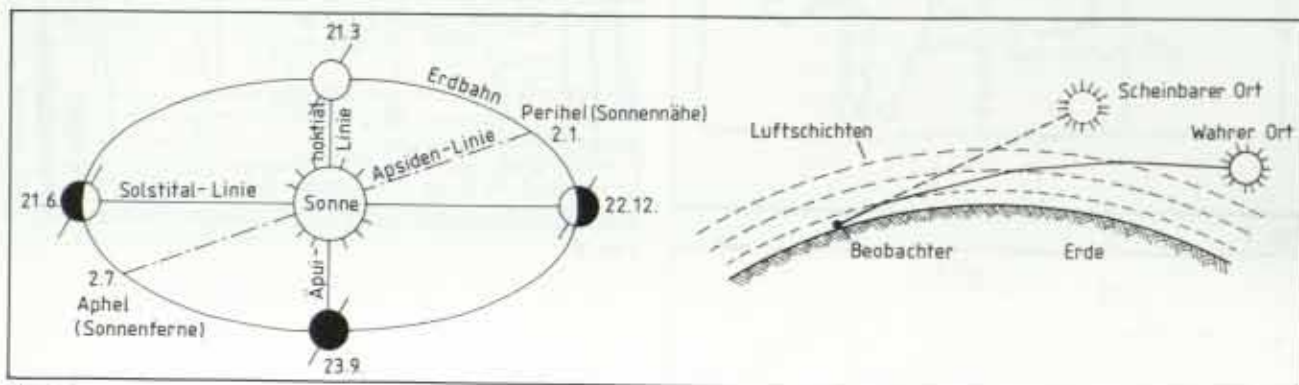


Fig. 8



Fig. 9

Fig. 6 Change in the Visibility of Fixed Stars (Polestar) due to Precession

Fig. 7 Rotation axis of the Earth projected onto the celestial sphere (after Petri 1978)

Fig. 8 Example of Refraction of the Sun

Fig. 9 Setting Points of Fixed Stars on the Kirthar Range Profile at different Epochs

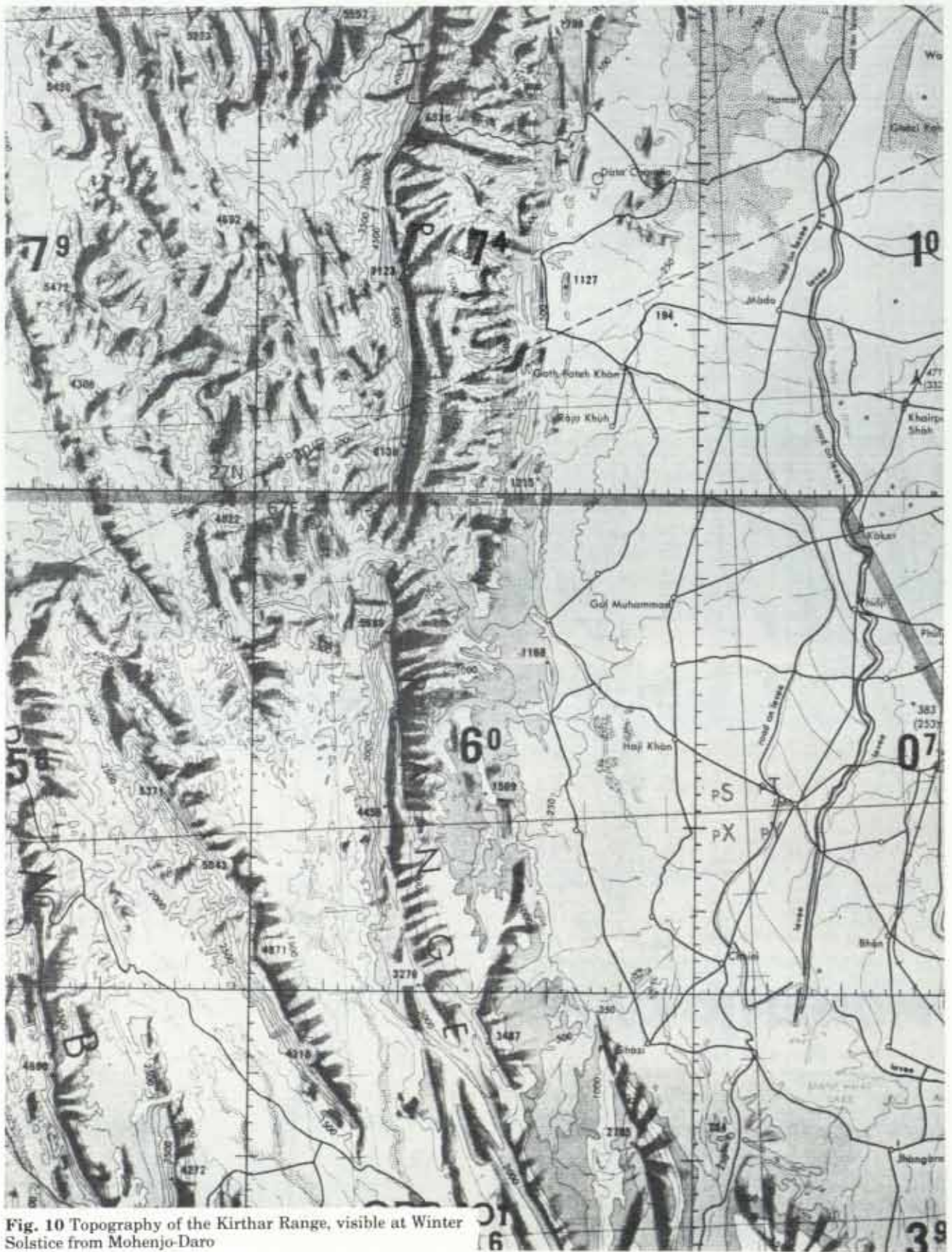


Fig. 10 Topography of the Kirthar Range, visible at Winter Solstice from Mohenjo-Daro



Fig. 11 Topographical Map of Mohenjo-Daro with General Access Axes (1-7)

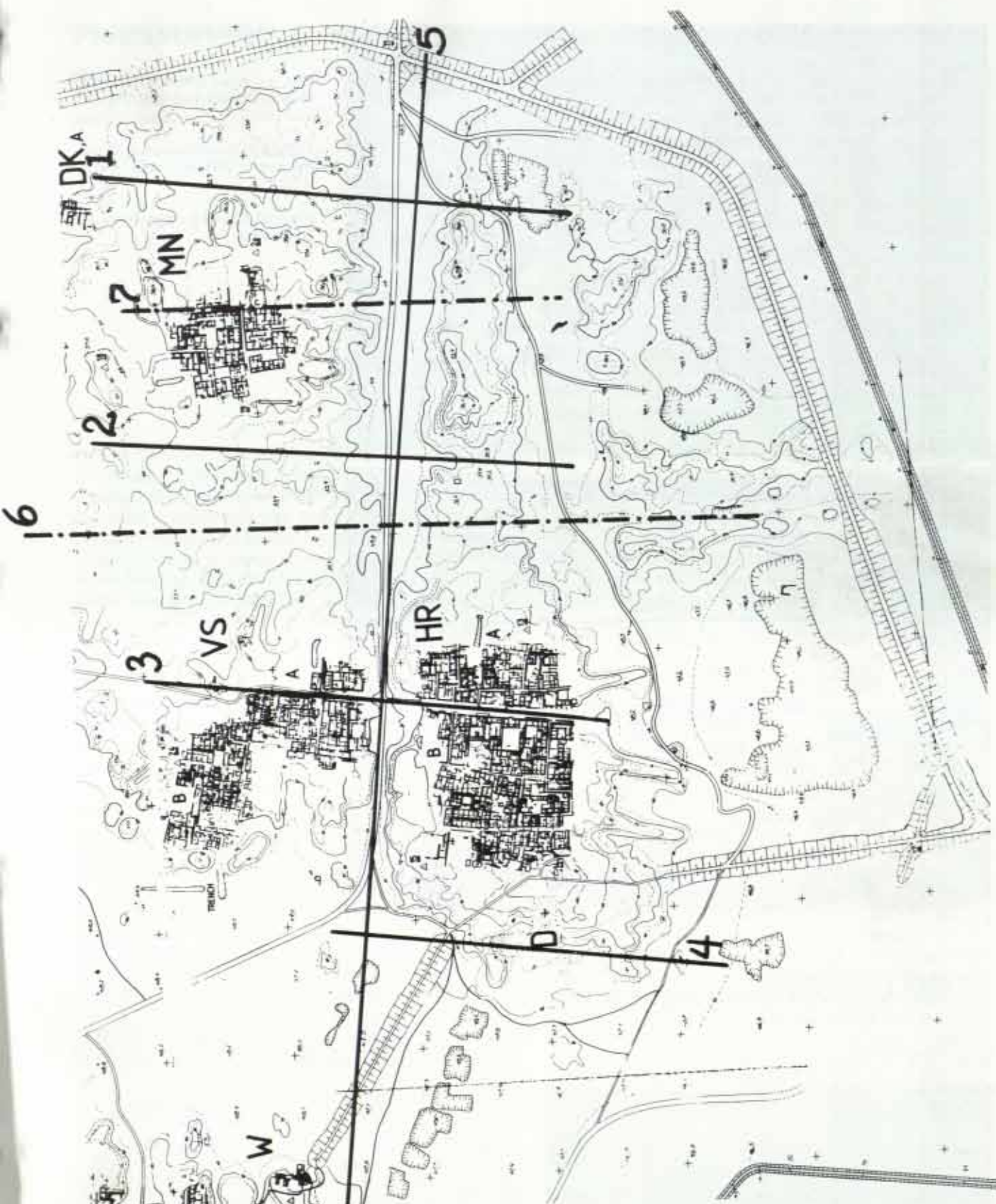
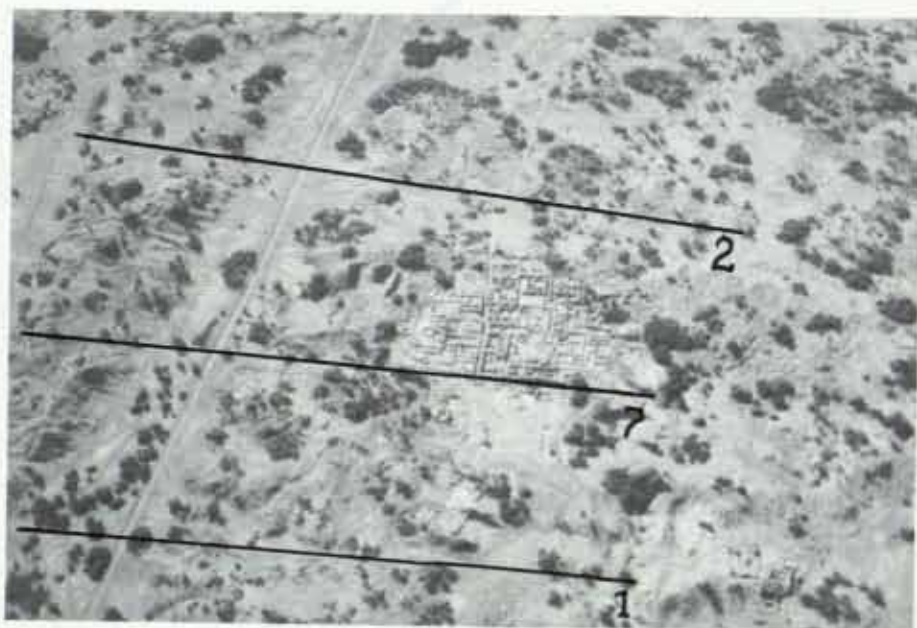


Fig. 12 Access Axes in Sites D, VS, HR, MN, DK-A



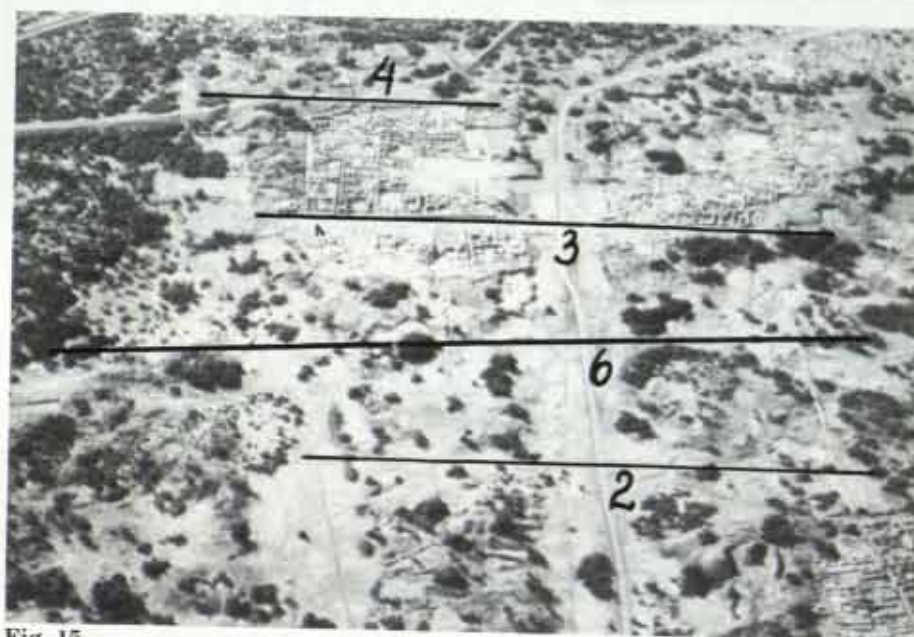
**Fig. 13** Axes 1, 7, 2 in DK-A, MN and DK-B

**Fig. 14** Axes 2, 6, 3, 4 in DK-B, between DK-B and VS, VS, HR, and DK-G

**Fig. 15** Points of Sunset at Winter Solstice in 2500 B.C. and in 1980 A. D.

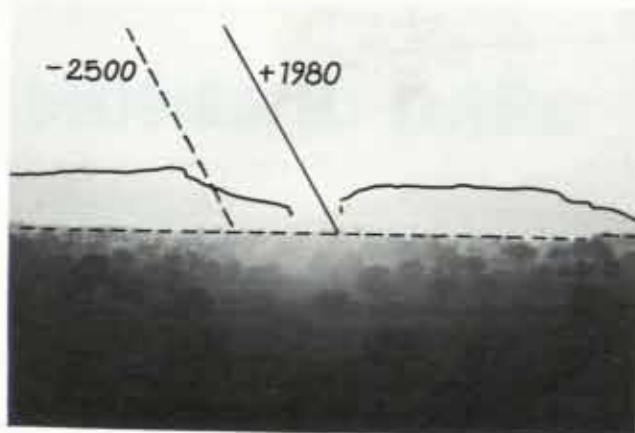
**Fig. 16** Street Axis in Southern Dales Area

**Fig. 13**



**Fig. 14**

**Fig. 15**



**Fig. 16**



## Preliminary Report on the Stūpa and the Monastery of Mohenjo-Daro<sup>1</sup>

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Henry Cousens' *Antiquities of Sind* was published (with delay, that is true) in 1929. The book contains the reports on the surveys carried out between the end of the 19th century and the second decade of the 20th century, which had already appeared in the *Archaeological Survey of India Annual Reports (ASIAR)* and in the *Progress Reports of the Archaeological Survey of India Western Circle*. The volume deals with the historical antiquities of Sind, especially Buddhist and Islamic ones. This fact is all the more striking as, N. G. Majumdar's *Explorations in Sind*, published in 1934, deals almost exclusively with the proto-historical antiquities of the region. A few years were enough to shift scientific and antiquarian interest radically in a new, unsuspected direction, which is still being pursued with success at present.

When, with the excavation campaign of 1921-22, Rakal Das Banerji began to dig at Mohenjo-Daro, he was certain that it was a historical site, and since the ruins did not look Islamic, they had to be almost certainly Buddhist. The known facts (Harappa's excavations had barely begun the year before) did not allow room for doubt. Buddhist archaeology had been known to be very promising in North-Western India since the time of Cunningham, who had provided the first plans and information on Taxila, Takht-i Bāhi, Jamāl Garhi, etc. in his *Archaeological Survey of India Reports (ASIAR)*. More recently, D. B. Spooner and H. Hargreaves had excavated successfully at Shāh-jī-kī Dherī (Spooner 1908-9; Hargreaves 1910-1). John Marshall had been excavating at Taxila since 1913. Beyond the Khyber, A. Foucher was about to begin the Afghan chapter of North-Western archaeology after his spectacular, even questionable, expeditions had revealed the Buddhist antiquities of Chinese Turkestan. Sind, as Cousens had partly shown, might promise the discovery of equally prestigious Buddhist sites. Buddhism had been chosen by Western scholars

as a presumed weak spot in Indian civilization on which to work, so as to be able to present an ideal, no longer contestable, model for the whole of India. It was distorted to represent European rationalism in Asia, being free — or so it seemed — from practices that were judged unacceptable, and having moreover acquired in Western eyes the merit of being a "progressive" historical movement. A. K. Coomaraswamy and Giuseppe Tucci, in different ways, were to oppose these interpretations.

All this must be taken into account to understand Banerji's position, even without intending to absolve him from his limited but by no means negligible responsibilities. Mohenjo-Daro appeared to him as a cluster of five shrines<sup>2</sup> built "on a group of five islands" floating on dust. Two of these "shrines" were excavated. The first, indicated by Banerji as Site No. 1, corresponds to the present Stupa Area, and forms the part of the excavation dealt with here. The "second shrine, on the larger island", only partly unearthed, is also in sector SD, to the north-west of the first, and thus to the north of the "Great Bath". Banerji's excavation report has remained unpublished, and on these initial excavations at Mohenjo-Daro we have only the meagre information from Banerji reported in *ASIAR*, 1922-23.

### Site No. 1

According to this report the results of the excavation can be summarized as follows. On a rectangular terrace of backed bricks ("a high artificial tower") there is "a quadrangle consisting of series of chambers on all four sides enclosing a courtyard with a stupa in its centre" (Banerji 1922-3; see here Fig. 1). Its drum, made of unbaked bricks, rose on "a stepped platform" which presented "a small porch on its eastern side", leading "to a small passage" from which two flights of stairs led off (cf. Figs. 5, 6), intended perhaps "for the use of pilgrims who wanted to go up to the base of the stupa" (*ibid.*). At the end of the passage (shown by No. 65 in the plan given by Marshall; see Fig. 1; cf. Fig. 5) was a niche, "which once contained a seated image of Buddha, made of clay, but with a core of burnt bricks" (*ibid.*). The stupa had been excavated by treasure-seekers<sup>2</sup>, who left among the debris the presumed "reliccasket of white marble and its lid of polished conch-shell" (*ibid.*: 103). The sides of the drum were "covered with fresco-paintings" on which fragments of an inscription were preserved, similar to those "discovered by Sir Aurel Stein in Khotan" (*ibid.*: 102-3).

The rooms around the *pradakṣiṇāpatha* turned out to belong to four different periods (cf. Fig. 1). Coins of

Vāsudeva I, of the Siva and Bull type, were associated with the top layer; with the third layer "thick oblong copper coins" resembling "the indigenous issues of the ancient city of Taxila" and — in Room 3 — "numerous fragments of images of stucco, turned into porcelain by the action of intense heat", among which was found "the bearded head of a barbarian wearing a pointed cap, similar to the figure discovered in one of the monuments at Taxila" (*ibid.*: 103). At least "four thick oblong copper coins inscribed with pictograms" were associated with the lowest level. Moreover, "the walls of the earliest period and a pavement were found below the level of the ashes over which the platform of the stupa was built" (*ibid.*).

Two other trustworthy pieces of information given by Banerji, are worth recording. The first is that the sides of the "stepped" platform of the stupa "were covered with ashes, proving that the shrine was destroyed by fire"; the second, disconcerting is that "the entire area of site No. 1 was covered with funeral urns of various size and shapes. The majority of them are pointed at the bottom but some of the large jars are round. These contained smaller but pointed funeral urns and miniature necropolitan pottery" (*ibid.*: 102, 103). It thus seems that the Buddhist area was covered by material belonging to the proto-historical town.

### The Stūpa

The publication of the Stūpa Area is owed to J. Marshall, who included it in his *Mohenjo-Daro and the Indus Civilization* (1931). Marshall, then Director General of the Archaeological Survey of India, immediately assumed the direction of the excavations at Mohenjo-Daro as soon as it was realized what the site involved. In his report Marshall declares explicitly more than once that he is not in agreement with Banerji's conclusions — but the excavation of the Stūpa Area was by now completed, and for publication he could do nothing but rely on Banerji's *Report*, which had been submitted to him (*cf. Majumdar 1931: 128*) and was left unpublished because of him. It was only in 1924, however, that Marshall could see "the collection of antiquities" recovered by Banerji (*Marshall 1923-4: 48*) — a delay that had serious consequences as far as we are concerned, since in the meantime fragments of crucial importance had disappeared — or so it seems (*see infra*).

The whole complex formed by the stūpa and monastery — according to Marshall (1931: 113) — "was many times repaired or rebuilt".

The plinth of the stupa (Banerji's "platform"), which "sprang from a little lower level than the earliest of the pavements" of the courtyard, was covered later

on by three successive retaining walls (*cf. Fig. 1*), to which the different floors brought to light in the courtyard refer. The projection clearly visible along the body of the plinth (*Figs. 7, 8*) would immediately suggest the level of one of these floors, but it is placed too high in relation to the other buildings of the courtyard, and does not mark any difference in the mural texture of the building. According to Marshall the monument was built in about 150 A.D. and lasted until about 500 A.D. (*ibid.*: 123).

The facing of the plinth is of a "somewhat rough and ready kind compared with that of the prehistoric monuments beneath" (*ibid.*: 114), already glimpsed by Banerji and hence partly excavated by B. L. Dhama, under the direction of Marshall. The most curious characteristics of this plinth were, for Marshall himself, its abnormal height and an approach in the centre of its eastern side that was "more than usually elaborate" (*ibid.*; *see Figs. 5, 6*). We may note here also the total absence of mouldings and half-pillars. It was also impossible to establish whether the stairs of such an approach continued westwards, going up by one floor more. The drum of the stūpa, in unbacked bricks, and hollow inside (*Fig. 9*) was another detail that was difficult to explain. Its inner facing — Marshall says quoting Banerji's unpublished *Report* — "laid with care" and presenting "a smooth appearance", was originally intended to be hollow and "must have been plastered and painted" (*ibid.*: 115).

Marshall objects that on the internal facing there is no trace of plaster, that the painted fragments found by Banerji's assistant Wartekar, "while clearing the western side of the stupa plinth" could not be said to have come from inside the drum, that no Indian stūpa presented a similar typology and that the room was too vast to have been vaulted in unbacked bricks. None of the relic chambers Marshall had seen were "at all comparable in size with this supposed one at Mohenjo-daro (. . .) All things considered, therefore" — the famous archaeologist concluded — "I incline to the view that the interior of the drum was filled in as usual and covered with a dome of the customary pattern" (*ibid.*). The unlikely reconstruction of the stūpa proposed by Marshall, prudently suggested from north-west or from north-east, is reproduced here at *Fig. 13*. The relationship between plinth and drum can in no way correspond to the real one, the actual plinth being much higher, as one can see from the drawings given by Marshall himself (*cf. Figs. 2, 3*) as well as from photographs (*Figs. 5, 8*).

Marshall must however have continued to turn over and over in his mind the singularity of this hollow drum: at least until he believed he had found a solution in Stūpa A4 at Kālāwān (Taxila), excavated by himself. The plinth of this stūpa (*Fig. 19*) shows "a circular relic chamber, which is no less than 13 ft. 3 in. in diameter, with walls which start to cove inwards from a height of between 2 and 3 feet above the floor"

(Marshall 1951: 323). On the internal walls there were "several layers of whitewash" and it was therefore necessary to ask oneself why this chamber was not "permanently closed" as usual, and where the entrance was to be found — both problems without an answer. "A similar problem" — Marshall remembered — "is presented by the great Kushān stūpa at Mohenjo-daro in Sind, the relic chamber of which was also circular and finished off inside with mud plaster. In that case the evidence was not so clear as it is a Kalawan, and I felt inclined to take the view that the interior of the drum had been filled in and covered with a dome of the customary pattern. With this discovery, however, of this stūpa at Kālāwān, it is necessary to reconsider this view, since it is quite certain that in this case the chamber could not have been filled in" (ibid.: 324).

Actually, there are important differences between Stūpa A4 of Kālāwān and the one at Mohenjo-Daro. The first is that at Kālāwān the relic chamber is in the plinth, while at Mohenjo-Daro it is in the drum. The second is that in the case of Taxila the walls incline progressively inwards until they close without the need for a vault, in the Indian manner. This is not so at Mohenjo-Daro. It should be noted, however, that in the North-Western regions (this Marshall did not know) examples of large vaulted rooms in unbaked bricks are documented. I refer the reader to Room 36 at Tapa Sardār (Ghazni), which measured 8.00 x 7.70 m. (Taddei 1978: 578).<sup>3</sup> At Mohenjo-Daro, moreover, we are confronted by a stūpa built with two different materials: the plinth is built with baked bricks taken from the proto-historical ruins, and the drum is of unbaked bricks. This also could be explained, at least at first sight, because this mixed technique is found in other stūpas of Sind. The core of the Kahujo-daro stūpa near Mīrpur Khās, the most famous Buddhist monument of Sind, was circular and made of sun-dried bricks (Figs. 14, 15), the walls of burnt bricks around it "being only a few bricks thick" (Cousens 1929: 83). When Cousens examined the stūpa in 1909 "some portion of the core of the tower, of sun-dried bricks, protruded from the top" (ibid.: 82). This technique is documented by Cousens also at Depār Ghāngro, near Brahmanābād, whose stūpa had "a core of sun-dried bricks" (ibid.: 59 and Pl. XVII). Equally clear is the case of the stūpa at Sudheran, "built of unburnt brick faced with large burnt bricks". Here only "the mud core or tower" was actually visible — "all that was left of the original brick tower of the stūpa — which, like others of its kind was built of sun-dried bricks, regularly laid, with an outer shell or casing of ornamental burnt bricks" (ibid.: 101 and Pl. XXX).

The most interesting thing about the stūpa of Sudheran is its relic chamber, which is of rather a special type (Fig. 16). It is located at the same level at which the presumed one of Mohenjo-Daro is found, namely on the upper level of the plinth — the "terrace"

which at Sudheran "surrounded the base of the tower" (ibid.: 103). Having made the usual tunnel, Mr. Bhandarkar, whose words Cousens reports<sup>4</sup>, actually found "a dāgoba such as we find in the cave temples, standing 6 feet 9 inches high, composed of sun-dried bricks covered with plaster, the surface of which had been painted. It was completely built and embedded in the tower" (ibid.: 103-4). A relic chamber placed at the same level, attainable with difficulty through a shaft similar to that "down the centre of the dāgoba was found leading down to the relic chamber of the Sue Vihār stūpa near Bahāwalpūr, not far north-east of the Sind border": thus went Cousens' commentary to Bhandarkar's finding (ibid.: 104).

In spite of this last example, the stupa at Mohenjo-Daro cannot fail to puzzle. The difficulty does not arise so much from the fact that only the core of the drum is of unbaked brick (only the upper part of the stūpa might have been rebuilt in a period in which this technique was in use), as from the fact that the core presents a cavity of such large dimensions, not comparable with the one at Sudheran. Why ever would a core of this kind, consisting only of a thin circular wall of unbaked brick which then had to be encased by baked bricks, be built? This is not a credible way of building stūpas, and we could only conclude that the entire drum was of unbaked brick. But we would have in this case a drum reconstructed in a material different from that employed everywhere else in the area and in the stūpa itself, whose plinth, enlarged in periods III and IV<sup>5</sup>, is made entirely of baked bricks. It must be said also that this has no parallel in any other stūpa in Sind or in North-Western India.

We have seen how on the eastern side of the stūpa there is an unusual, elaborate "entrance", which is certainly unique among all stūpa entrances known to me in Western India and Central Asia. However, in this instance too the stūpa of Kahujo-daro near Mīrpur Khās, whose west side "was probably the front of the building" (ibid.: 85) comes to mind (Fig. 14). A terracotta image identified by van Lohuizen-de Leeuw (1979: 161-2 and Pl. 78; cf. Cousens, 1929: Fig. 14 on p. 95) as Padmāpaṇi comes from one of these niches. Moreover, there was perhaps "a staircase by which to ascend to the terrace round the base of the tower" (ibid.), which led to an upper *pradakṣiṇāpatha* as at Mohenjo-Daro (?) and as in the monumental ancient stūpas of Central and Southern India, for example Stūpa 1 at Sāñcī.

There are thus possible explanations, even if not fully satisfying, for some of the singularities of the stūpa at Mohenjo-Daro. Other difficulties remain. These regard the exaggerated height of the plinth in relation to the height of the drum that it must have had and the absence of mouldings and half-pillars, or of other architectural decorative elements indicating the presence of niches, as well as the absence of carved bricks, well known from the stūpas of Sind and Gujarat, as for example at Mīrpur Khās (Cousens,

1926: 88 and Pls. XX, XXIV, XXV A), at Sudheran (*ibid.*: Pl. XXXI), at Depār Ghāngro (*ibid.*: Pl. XI), at Jarak (*ibid.*: 108), at Devnīmōrī (Mehta and Chowdhary 1966: 139-40 and Pls. LVIII, LIX, LXI-LXV). Moreover, in the debris and on the different floors brought to light in the courtyard testifying the long life of the site, not the least fragment of a figure or object that could be recognized as having to do with a cult has ever been found. I refer not so much to those terracotta panels that decorated the plinths of other stūpas (the well known ones of Mīrpur Khās, but also those of Thūl Mīr Rukān; cf. Cousens 1926: 99) as to those small cult objects that a sacred area generally yields, from lamps to those small votive stūpas and tablets known — to confine ourselves to North-Western India — from the region of Ghazni (Taddei 1970) to pre-Tibetan Ladakh (Tucci 1932-XI: Pl. VII ff.) and also present here in Sind, as has been shown by van Lohuizen-de Leeuw (1979: 168-9).<sup>6</sup> It is thus a real pity that no documentation exists of the fragments of that Buddha image which according to Banerji was found at the western end of passage 65.

Around the main stūpa there were some minor ones, "but nothing was left of them except their plinths" (Marshall 1931: 116).

They were all removed to allow trial trenches with which to reach the proto-historical levels, and are documented by one photograph only (Fig. 4).

### The Monastery

When the plinth of the stūpa was intact, and on it stood the drum, the whole building had to be an enormous, overhanging structure, definitely to high and disproportionate, especially during periods corresponding to layers III and IV, when particularly thick retaining walls added to the plinth. Even more so in that it was located at the centre (ideal, not geometric) of a not very large courtyard around which were arranged the cells and other rooms of a monastery — itself no less unusual than the stūpa. It too is built with baked bricks taken from the proto-historical buildings, but stuck together with mud instead of mud and gypsum (Marshall 1931: 116). Originally a two-storeyed structure, it must have had a wooden roof and have been preceded by a wooden verandah "carried on brackets instead of the more usual pillars, since the space between the stūpa and cells was too constricted for a pillared verandah" (*ibid.*: 117). How otherwise could one explain "the large quantities of ashes found by Mr. Banerji in the courtyard, on the plinth of the stūpa and in the cells — the outcome, obviously, of a general conflagration" (*ibid.*)? In the monastery various phases are documented too. Here is

for example the "Assembly Hall" at the north-east corner (Fig. 1), whose roof was at first supported by three central pillars, and subsequently, the room on the south side having been made smaller, by six pillars to which half-pillars along the walls correspond. Also in the cells' floors which "were sometimes lower than the corresponding floor of the courtyard" (*ibid.*: 119) are documented, as for example in Room 24, where the difference in level between its last floor and the corresponding one outside is about 1 ft. 6 in. (ca. 45 cm.). The cells comprise one of the more evident singularities of the monastery. They appear to have consisted for the major part of two rooms, contrary to universally documented custom. The cells of Buddhist monasteries correspond in fact to a very precise type, spread from the Ganges valley and beyond to North-Western India and Central Asia, from Nālandā (Fig. 20) to Taxila (Fig. 17), to mention two of the most well-known sites. Around a quadrangular courtyard single rooms are arranged, whose door opening, provided with only one jamb, is generally located immediately next to the adjacent cell.<sup>7</sup> The cells are obviously all alike, or else they present negligible differences. Marshall writes that at Mohenjo-Daro the inner room was meant for sleeping and the outer one for living purposes (*ibid.*: 119). But what about the two symmetrical groups of rooms 41-42-43 and 46-47-48 (Figs. 1, 10)? Here there are cells not of two rooms but of three, the third being a sort of dead-end corridor. On the other hand, we have also cells of only one room, as for example Nos. 27 (Fig. 12), 28, 29. As regards rooms Nos. 25, 27, 29, of fairly large dimensions, Marshall himself does not believe that they are cells: "as there is no sleeping room connected with them ... it is probable ... that they were used for other purposes" (*ibid.*). The layout of the monastery and the differences between the cells constitute a considerable problem, which already in itself indicates that this monastery is very much *sui generis*. But there is more.

On the eastern side of the quadrangle there are no cells but four rooms (Fig. 1). Room No. 4 would be the "Entrance Hall". This is Marshall's idea, since according to Banerji the entrance to the quadrangle "lay through a pillared hall in the north-eastern corner" (Banerji 1922-3: 102), that is to say through the room that Marshall calls "Assembly Hall". Marshall — I believe — thought that the entrance was through No. 4 since the room is aligned with the stūpa, and an entrance must have existed somewhere. The entire eastern side of the Stūpa Area actually overlooks a steep escarpment, and today it is not easy to understand how and why the entrance had to be on this side. The ideas of Banerji and Marshall on this point owe more to exclusion than to evidence.

North of the entrance there is a rectangular room, No. 3, supposed to be "a small chapel, in which Mr. Banerji found eight fragments of stucco, painted with alternating bands of red and black and belonging, as he supposed, to the robe (sanghaṭī [sic]) of a Buddha

figure, as well as the torso of a clay image of a Bodhisattva with a necklace or garland, coloured red, around his neck" (*ibid.*: 117). These fragments, like the others in passage 65 and others yet again (*cf. infra*) have never been published, and apparently have never been seen even by Marshall. I shall limit myself, therefore, to observing that it is not easy to imagine a *saṃghāṭi* "painted with alternating bands of black and red", even if these should be decayed colours. Looking at the plan (*Fig. 1*), chapel No. 3 seems to have been made by altering an earlier room whose entrance from the *pradakṣiṇāpatha* side was closed.<sup>8</sup> The pedestal of the image stood on this side of the room, or so it seems. It is a most curious arrangement. I do not know any other example of a chapel placed along the *pradakṣiṇāpatha* of a stūpa whose image has its back turned to the main stūpa.

At the two extremities of the eastern side there are two large rectangular rooms, Nos. 1 and 5. The first has already been mentioned. The second was also altered, though without yet doubling the number of pillars, but rather widening the outermost ones (M and O on plan at *Fig. 1*). Nothing indicates that Room 1 was the Assembly Hall, "a usual if not indispensable adjunct in the larger monasteries of this period", as Marshall says (*ibid.*). As far at least as its second phase is regarded, this idea should be rejected, because the space between the four walls with half-pillars and the six central pillars is very limited. It would not have made sense to gather monks in a place where they could not even be seen. As far as room No. 5 is concerned, Marshall writes that the use to which it was put "can only be surmised" (*ibid.*: 118). It is not the refectory, Marshall explains,<sup>9</sup> because, in his opinion, this is more appropriately located elsewhere.

Let us consider rooms Nos. 26, 27a, 29a, 30a on the western side, belonging to layer I. Their walls "are not bounded with those of the cells in front of them" (*ibid.*: 119), and they may thus have been "a subsequent addition." "I surmise" — writes Marshall — "that they served as kitchens, pantries and store-rooms, and, if this surmise is correct, it is highly improbable that they were contemporary with the original edifice. Up to the end of the third century, if not later, it was unusual to have kitchens, pantries, and the like attached to monasteries. Before that the monks seem to have begged and eaten their food in the towns, or to have prepared it, each for himself, in his own cell. It was not until conditions became more luxurious that common kitchens, storerooms, and other such amenities were provided, and the monks thus enabled to devote more time to their religious and literary activities" (*ibid.*).

This *ad hoc* reconstruction of Buddhism, so simply-mindedly evolutionist, is accompanied by a tranquillizing and respectable interpretation of the complex: next to unusual two and three roomed cells for monks (surely destined for the most religious and literary ones . . .) are an Assembly Hall, a Common Room as

in British boarding-schools, kitchens, pantries and store-rooms. There is no evidence for all this, but the monastery is created. And yet, not everything works out. The long and narrow room No. 40 (which from the plan — here *Fig. 1* — appears to have been closed at the time of layer II) could indeed be another "image shrine, like No. 3; but it is hardly likely that there would have been two such shrines in the residential quarters" (*ibid.*). The far rooms on the north side (Nos. 53-58) "were added later on, some of them probably when the stūpa and monastery were repaired, probably in the third century A. D., and others still later, as indicated by the different hatching in the plan, (. . .) it is impossible to affirm anything definite regarding their purpose or date beyond the fact that they were later additions" (*ibid.*). This second series of rooms on the north side and the group of rooms on the west side, along which perhaps others, now lost, were located to close the corner, escape the logic of a monastery plan. They form not only an unusual second row of rooms and not only do not correspond to the usual monastic typology (on the north side, there are long narrow rectangular rooms), but seem also to lack any communication with the rooms which give on to the *pradakṣiṇāpatha*.

### The Findings

But there are other disconcerting details, relating to the material found in the monastery. In the narrow "torpedo-shaped" chamber No. 22 (*Fig. 11*) that Marshall shows to have been an integral part of the monastery when it was built, "Mr. Banerji found a large number of pots with pointed ends, which he took to be burial urns" as well as "two large earthen jars . . . which contained smaller burial urns, each of which in its turn contained uncalcined human bones, in crude crucible-shaped terra-cotta reliquaries" (*ibid.*: 120). This material is unequivocally proto-historical, and in this case not even Marshall manages to square the figures: "Are we to infer that these vessels remained in use right down to the time of the Kushāns? Or, in the alternative, that for some inscrutable reason the Buddhist monks preserved these relics of an older civilization in this small chamber? And how, again, are we to explain the presence of layers upon layers of pots and debris in a chamber provided with an open doorway and never apparently walled-up?" (*ibid.*). Marshall, however, accepts the data emerging from the excavation, "though *prima facie* it is unlikely that such a chamber would have been specially made amid the living quarters of the monks" (*ibid.*: 112), and seems to show no doubt about the nature of the monastery.

Also "a large earthen jar of the ghara type" found in room 27 (in the corner marked on the plan with an X; cf. Fig. 1; see also Fig. 12) contained "a number of the same kind of small vessels with pointed ends", containing in their turn fragments of bone mixed with a "thickish gluey soil" (*ibid.*). The problem is that also in this case the material is stratigraphically related to the monastery, and not to the lower proto-historical layers: "we can be quite sure" — Marshall writes — "not only that the jar is of Buddhist date but that it is relatively late, even at that" (*ibid.*).

According to Marshall's report, "the minor finds from the monastery quarter" — apart from the coins and a small head of which more will be said later — consisted of "a roughly made toy horse of terra-cotta, a miniature jar, and a fragment of a marble relic casket from Room 33;<sup>10</sup> a round lid of conch shell from Room 42" (*ibid.*: 122). In Banerji's brief account of excavations in ASIAR (1922-3: 103), we read that "the finds in site No. 1 consist of flint scrapers, cores, bouchers, dice of polished marble and terra-cotta; fragments of a marble chair, pieces of small images and umbrellas of white marble, oblation vessels of conch-shell, bangles and ornaments of conch, beads of various stones, copper and bronze, pipes of cornelian and pottery of various shapes", as well as "funeral urns of various size and shapes" that covered the whole site. We find ourselves confronted, therefore, with material that has nothing to do with the Buddhist period and which seems definitely to belong to the proto-historical town.<sup>11</sup>

Important exceptions are given by the coins and by "a tiny bearded head of painted stucco from Room 45, which is evidently a non-Indian type and, as Mr. Banerji suggests, may well have been meant to represent a Scytho-Parthian or Kushāna" (Marshall 1931: 122). Its finding spot is curious (room No. 45, according to Marshall's logic ought to be a monk's bed-room), but it may have "travelled". Unfortunately this head is unpublished, and from what he writes we may be allowed to assume that not even Marshall had ever seen it. If it was really a Kushāna head, this would be the only fragment — on the basis of the known iconographies of North-Western India and of the Ganges valley, where Kushāna donors are often represented beside images of the Buddha or of Bodhisattvas — that could accord with the nature of the site, given that the fragments of images from passage 65 and shrine 3, they too unpublished, have always been illegible.<sup>12</sup>

The coins discovered on the site are very numerous because most of them came from three authentic hidden treasure-hoards. The largest hoard, of 1684 coins, was found in room 34 "in an earthenware pot, which Mr. Banerji discovered just below the second floor... at a depth of 3 ft. 6 in. beneath the original surface" and consisted of square coins, "local issues of Sind, since they have been found at Mohenjo-daro and (more recently) at Jhukar near Lārkhāna, but nowhere else

in India" (*ibid.*; see note 14). According to N. G. Majumdar, who has given too brief an account of them, these coins cannot be earlier than the fifth century A.D. (Majumdar 1931: 128) and van Lohuizen-de Leeuw (1979: 172-3) considered them to be later, a possible issue of the Hindu dynasty ruling Sind in the second half of the 7th century. Almost all the other coins from the site are Vāsudeva I's. These latter are also found in the largest hoard of room 34, and form a second hoard of about 1100 coins found "during the excavations of 1927-8 in the Stūpa section" (Majumdar, 1931: 128, n. 1);<sup>13</sup> still others were found "scattered here and there in the débris" (Marshall 1931: 122) as well as in the smaller hoard of 76 coins in room 35 (*ibid.*).

It is well known that Kushāna coins were current long beyond the end of the dynasty, and that they were accompanied by imitations. The fact that in the hoard of 1684 coins, consisting for the most part of late local issues, coins of Vāsudeva I were also found and that other Kushāna coins were among the surface material and in the debris, indicates that also at Mohenjo-Daro Kushāna coinage was current at a late period. The numismatic material from the Stūpa Area appears to be stratigraphically connected with the site's last period of life. This can be said for sure, even if the stratigraphical information given by Marshall is inadequate. The hoard of 1684 coins was found "just below the second floor" of room 34, "at a depth of 3 ft. 6 in. beneath the original surface", but it is evident that at that point the second floor did not cover the hoard, composed of material that is too late to be referred to layer II. The hoard was in a pit, which can have been made at any time. This is probably also true for the small hoard of 76 coins in the adjacent room 35. As far as regards the other big hoard found in the Stūpa section" during the excavations directed by Mackay, the fact that the Kushāna coins of which it was composed were "badly corroded" although they were in a jar (Mackay 1937: 15; cf. here note 12) seems to indicate that they were collected in a "treasure-hoard" at a considerably later period than that of their issue.

The coins coming from the site thus do not give reliable information about the monuments, and do not seem in any case to be referable to the most ancient historical layers.

### Some More Problems

The plan of the Buddhist complex of Mohenjo-Daro is very unusual. Normally monastic groups have one or more stūpa courts where, next to the main stūpa, minor stūpas can be found. Moreover, chapels can open along the *pradakṣiṇāpatha*. Beside the stūpa court, but

clearly distinct from it, the monastery is located, formed by cells arranged along the sides of one or more courtyards. The reasons for such an arrangement can be easily understood. Monastic life has rules that cannot be continually disrupted by the presence of the faithful. Exceptions can be found, which can be explained, but the norm is very well documented. A notable exception, on the other side of the sub-continent, is given — to make an example — by the gigantic complex of Paharpur (Fig. 21). Here the courtyard is so vast, however, that there can be no interference between the monks' life in their cells arranged along the perimeter of the compound and the cult life around the central stūpa. Moreover, late architectonic and monastic organization in the East differs in part from that known to us in Western India, even in post-Kushāna period. See for example the monasteries of Tapa Sardār (Taddei 1978; Taddei/Verardi 1978) and of Adžhinatēpa (Litvinskij/Zemal' 1971), which have, from this point of view, a traditional layout. Also at Taxila, in Pippala's earliest monastery (Fig. 17) — which, according to Marshall's chronology dates to the Kushāna period — we have, if a comparison with Paharpur is possible, a similar exception (cf. Marshall 1951: 365 ff.). This can probably be explained by the fact that the site was a hermitage, the "public" stūpa of Taxila being the *Dharmarājikā*. Also in the monastic courtyards around this latter stūpa minor stūpas are found (cf. *ibid.*: Pls. 45, 61), but they too are destined for private worship.

The site of Devnīmori in Gujarat is perhaps the most appropriate example that we can consider, since — unlike Mīrpur Khās and the other sacred Buddhist areas of Sind — it has been extensively excavated. Because of its chronology, revised by Mme. van Lohuizen-de Leeuw (1979: 164 ff.) and of the architectonic and stylistic characteristics of its main stupa it is strictly linked with the monuments of Sind — they too dated by the late Dutch scholar to the 6th-7th century A.D. and not to the late Kushāna period (*ibid.*: 159 ff.). At Devnīmori the division between monastery and sacred area is respected as usual. The plan of Vihāra I (see Mehta and Chowdary 1966: between pp. 36 and 37) appears as a text-book example, utterly different from that at Mohenjo-Daro.

It is indeed difficult, in this last site, to imagine, as Marshall does, monks seated beneath the wooden verandah of the *pradakṣiṇāpatha*, where the space between stūpa and monastery is so limited. Even more difficult is it to imagine the presence of a "Bath" in the southeast corner of the same *pradakṣiṇāpatha* (close to one of the minor stūpas!), to be seen in the plan and in an old photograph (Figs. 1, 4) but not described by Marshall, who probably did not know how to explain its presence.

We might think that the stūpa of Mohenjo-Daro was not meant for public worship, that it too was a hermitage. This could explain the lack of any kind of decoration

on the stupa itself and, apart from an image in passage 65, the absence of those images that are indispensable for the *bhakti* of the faithful, but not in themselves necessary. This explanation, however, does not fit. The stūpa of Mohenjo-Daro is too big to have been built expressly for a similar purpose. Being built on the higher point of the ruins of the proto-historical town, it is made to attract attention, for the faithful. The monumental stairway on the eastern side, moreover, and perhaps even the presence of an upper *pradakṣiṇāpatha*, do not accord with such a hypothesis.

For these reasons, a comparison between the sacred area of Mohenjo-Daro and the unusual structures brought to light in Mound B at Jaṇḍiāl (Taxila), which for certain aspects could be made (see Fig. 18), does not seem to be valid too. The rooms that surround the Jaṇḍiāl stūpa are neither cells or chapels (with the exception of a small chapel in Court T). Marshall (1951: 356) underlines "the unusual plan of foundations" and observes that "In the Saka-Parthian period to which the stūpa is referable, we should not, of course, expect to find a quadrangle enclosed by rows of symmetrical cells, such as are characteristic of later monasteries, nor can we in fact be sure that any of the surviving chambers were used for residential purposes". The chronology of Taxila needs to be revised, and the structures of Mound B at Jaṇḍiāl might prove considerably later than has been thought, and, therefore, closer to those at Mohenjo-Daro but their fragmentary nature and scarce decipherability prevent us from saying more.

From the stratigraphical point of view, two important points must be emphasized. First of all, "under the platform [that is to say the plinth] of the existing stūpa a thick layer of ashes was discovered, proving that the existing shrine was built on the ruins of an earlier one" (Banerji 1922-3: 103). Actually, the layer of burnt material does not divide the Buddhist period from the proto-historical one. It will be remembered that "the walls of the earliest period and a pavement were found below the level of the ashes over which the platform of the stūpa was built" (*ibid.*). There is, therefore, a clearly recognizable gap between the earliest Buddhist layer and the subsequent ones. On the other hand, "from the sectional drawings on Pls. XVI (here Figs. 2, 3) and XVIII it will be seen that the prehistoric remains in the Stūpa Area commence immediately below the earliest Buddhist pavements. Indeed, it was because they happened to be so close to the surface that Mr. Banerji first lighted upon them when excavating the monastery" (Marshall 1931: 123). Thus there is no stratigraphical gap between proto-historical buildings and Buddhist monuments. The monuments of layer I must have been built, therefore, soon after razing the earlier ones.

It is the building technique (on which more will be said on a future occasion) that distinguishes the historical(?) from the proto-historical layers. In the Buddhist ruins

we find only bricks being re-used, provided of course that the assumption is valid according to which the proto-historical builders, as such, always used a better technique and those of the Kushāna or Gupta period, as such, a worse one. Such an assumption is certainly in line with the Indian theories about the progressive deterioration of this last *yuga*, but cannot in itself be said to be fully convincing.

The second important point, which has already been mentioned, is that according to Banerji, at the beginning of the excavation the plinth of the stūpa (but not the drum in unbaked bricks) was "covered with ashes" (Banerji 1922-3: 102) and that "the entire area of site No. 1 was covered with funeral urns" of a proto-historical type. This accords with the findings of proto-historical material in room 22 and 27, but stratigraphically would suggest a surprising conclusion: that the whole area should *not* be referred to the Buddhist period.

There are however findings that indicate beyond any doubt that the site was inhabited in the first centuries A.D. The fragments of painted plaster with inscriptions in *brāhmī* and *kharoṣṭhī* alphabets (Marshall 1931: 116), the fragments of pottery "bearing *Brāhmī* inscriptions... discovered by Mr. Banerji and subsequent excavators in chambers around the Stūpa and amidst the loose debris covering the surface of the Bath area" (Majumdar 1931: 129) as well as the head of a Kushāna personage, all indicate that the site was inhabited more than episodically in Kushāna time, whereas the coins show that people have settled here even in later times. What kind of settlement was there? We are confronted with stratigraphical and typological data that are contradictory. After a visit to the site, but before having been able to examine the findings, one is inclined to think that we have here a monumental area that was partly re-utilized and/or re-built in the historical period, but that not all the buildings are either wholly Kushāna or Gupta and post-Gupta.<sup>14</sup> This could perhaps explain the unusual layout of the sacred area. The stūpa would thus be un-typical because it is an adaptation of an earlier monument; the position and form of the monastery are so unusual because it would have been convenient to make use of earlier structures, which, all things considered, were still utilizable.

The presence of so many hoards of coins is surprising. One would say that the Stūpa Area and, with it, the whole area of sector SD comprised between Block 2 and Block 8, from which material from the historical period comes too and which is only recorded in passing by Mackay (1937: 15 ff.)<sup>15</sup> was a late inhabited area that made use of proto-historical structures. This does not necessarily preclude either an earlier construction of a stūpa or of a monastery, nor that these structures, in their turn, should have been built by adapting preceding monuments.

The unusual nature of the Buddhist monuments of

Mohenjo-Daro, the unclear stratigraphy (and, where it is clear, showing the contrary of what we would expect) as well as the absence of Buddhist iconographical material indicate the need for further study. Apart from possible new trial trenches, it will be necessary to collect and examine such findings as the inscribed pottery, the inscribed painted fragments of plaster, the fragments of images and the coins, of which so far we have so scanty a documentation.

#### Addendum

This article was already in press when the excavation Report submitted by R. D. Banerji to J. Marshall was unexpectedly published in 1984 by the Prithivi Prakashan of Varanasi under the title *Mohenjodaro. A Forgotten Report*. Although Marshall made use of the information contained in the report for the chapter on the Stūpa Area in his work on Mohenjo-Daro, he never allowed Banerji's work to be published. The Prithivi Prakashan is therefore to be praised for the enterprise. Unfortunately the published text is not accompanied by the photographic material envisaged by the author, and this makes it harder to read than if it were possible to check Banerji's statements by consulting the photographs.

A reading of the report does not alter the content of the above pages. Individual points could be examined at greater length now, but the crucial problem of the nature of the site as expounded above remains unchanged. However dissatisfied Marshall was with Banerji's excavation work, which had not been carried out according to stratigraphical criteria, he nevertheless made an accurate if not over-concise summary of the report, so that its publication does not disclose anything particularly new. It would be useful and interesting, however, — though long and difficult — to attempt in a future to collate the photographs of the objects found by Banerji in the Stūpa Area. From his description they appear to be mainly proto-historical, though the absence of reliable stratigraphical information regarding their exact finding spots allows for many possible interpretations.

## Footnotes

- 1 I spent a brief study period at Mohenjo-Daro at the end of February 1984, collaborating in the work of the RWTH Aachen and IsMEO of Rome. My visit was made possible thanks to funds assigned by the Ministero della Pubblica Istruzione to a project for archaeological research in Afghanistan and North-Western India directed by Prof. Maurizio Taddei of the Istituto Universitario Orientale of Naples.
- 2 They had excavated "beneath the hollow middle of the drum, to a depth of some 14 feet" (Marshall 1931: 115). One must not confuse the hole made by the treasure-seekers with the cavity in the drum of unbaked bricks.
- 3 The room has not really been published yet. One may see a photograph of it in *IsMEO* 1969: Fig. 9. An example of the special unbaked bricks strengthened with wooden sticks used to vault these large rooms has been given by Galdieri 1982: Fig. 14, 3-4, p. 38.
- 4 Cf. Bhandarkar 1914-5: 89-96.
- 5 Marshall uses Roman numerals to indicate the layers from the historical period and Arabic numerals for the proto-historical layers.
- 6 Actually, these votive stūpas and tablets are comparatively late, belonging to the post-Kushāna period. But as we shall see further on, there are reasons, emphasized by van Lohuizen-de Leeuw (1979), for considering the historical monuments of Sind to be later than has been usually been thought.
- 7 There are, however, examples in which the opening of the door is found in the centre of the wall. See here Fig. 21.
- 8 The hatching in the plan (here Fig. 1) shows, however, that all the walls belong to the same period.
- 9 "It may have been used as a 'common room', or at one time perhaps as a refectory", says Marshall (1931: 118), according to whom this room being "more simply designed" than No. 1 (in fact there are no half-pillars), is less likely to have been the "Assembly Hall". From a functional point of view, if anything, the contrary is true.
- 10 I intend to come to the nature of this "relic casket" on a future occasion.
- 11 As Marshall says (1931: 123), Banerji, at the beginning of the excavation, "lighted upon" the prehistoric remains "because they happened to be so close to the surface", and this can certainly partly explain the list of proto-historical material made by Banerji, who referred it, not knowing otherwise, to the Buddhist sacred area. Only partly, however. As has already been seen, and as will be said again below, "the entire area of site No. 1 was covered with funeral urns of various size and shapes" (Banerji 1922-3: 103). Moreover, the same brief list given by Marshall indicates that the findings are suspect (see the "toy horse of terra-cotta").
- 12 Probably Marshall never saw these fragments (of which he gives no photographs in his report), nor those fragments of "frescoes" found by Banerji's assistant Wartekar (cf. *supra*). The ambiguity with which Marshall deals with this point probably shows that he is trying to cover up his subordinates and his own neglect. He arrived first at Mohenjo-Daro only in the summer of 1924, and the excavation had been begun by Banerji in 1921.
- 13 Mackay writes: "in the excavation of Divinity Street we were so fortunate as to find a considerable hoard of Kushāna coins... numbered 1,078 in all, and despite being in a jar were very badly corroded. (...) This hoard of coins was found... beneath the floor of room 1 of the Buddhist monastery (Pl. VI) which partly overlay Divinity Street, that street having long since been filled up with debris and windborne dust" (Mackay 1937: 15-6 and Pls. LXXI, 1, 12; LXXXII, 11-7). One must not confuse "room 1" in Mackay's numeration with the "Assembly Hall" on the eastern side of the *pradakṣiṇā* patha.
- 14 All the Buddhist areas of Sind have yielded material that is unequivocally late-Gupta, and probably even post-Gupta, and not Kushāna. As we have seen, it is Mme. van Lohuizen-de Leeuw's opinion that all the historical monuments of Sind should be considered later than usually thought, forwarding convincing reasons to support this (see van Lohuizen-de Leeuw 1979). It may be interesting to recollect here that a non-monumental site as Mound 8 at Jhukar, fairly near Mohenjo-Daro, excavated by Majumdar, revealed the existence of dwellings of unbaked bricks that go back, according to him, to the fifth century A.D. (Majumdar 1934: 7). It is from this mound that the local coins found also at Mohenjo-Daro, and judged by van Lohuizen-de Leeuw to be probably of a later date, come from. Here too, associated with them, were Kushāna coins. Next to a Gandharan toilet-tray (*ibid.*: 18 and Pl. XIII, 2), to a small head that is not easily identifiable but which I would say is Gupta or post-Gupta (*ibid.*: 17 and Pl. XIII, 1), and to sealings of Shaivite character (cf. for example Inv. No. JK 763, for which *ibid.*: 17), were found "potsherds representing Buddha in relief, seated in preaching attitude, in temple with Dharmacakra symbol on śikhara" (JK 816, for which cf. *ibid.*: 16 and Pl. XIV, 26) and a "Limestone fragment representing a Bodhisattva figure (...)" (JK 71, for which *ibid.*: 18 and Pl. XIV, 27), which do not belong to the artistic tradition of Kushāna India, but to Gupta tradition.
- 15 Also this material will be examined on a future occasion, when Mackay's excavations are considered.

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Fig. 1 Mohenjo-Daro. Plan of stūpa and monastery according to Marshall (from Marshall 1931: Pl. XVI)

Figs. 2, 3 Mohenjo-Daro. Sections on AB and CD of stūpa and monastery according to Marshall (from Marshall 1931: Pl. XVI).

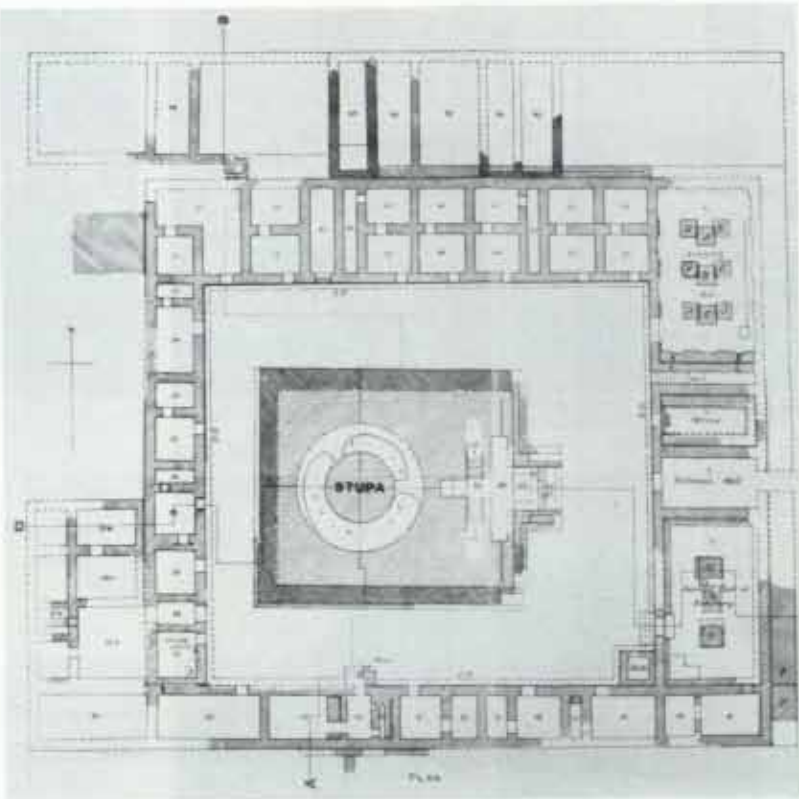


Fig. 1

Fig. 2

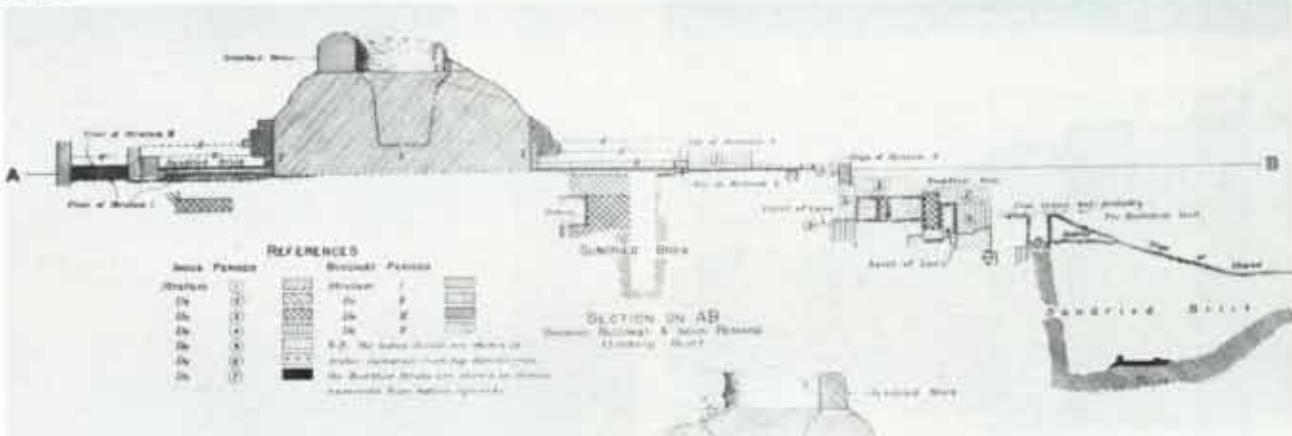


Fig. 3





**Fig. 4**



**Fig. 7**



**Fig. 5**



**Fig. 6**



**Fig. 8**



**Fig. 9**

**Fig. 4** Mohenjo-Daro. Stupa Area. Eastern side of courtyard showing structures removed later on (from Marshall 1931: PL. XV b).

**Fig. 5** Mohenjo-Daro. The stupa. (Dep. CS. Neg. L. 15002/26, IsMEO, Rome. Photo G. Verardi).

**Fig. 6** Mohenjo-Daro. "Entrance" and stairway of stupa (Dep. CS. Neg. L. 15002/25, IsMEO, Rome. Photo G. Verardi).

**Fig. 7** Mohenjo-Daro. Western side of stupa plinth (Dep. CS. Neg. L. 15002/21, IsMEO, Rome. Photo G. Verardi).

**Fig. 8** Mohenjo-Daro. Western side of stupa (Dep. CS. Neg. 15002/23, IsMEO, Rome. Photo G. Verardi).

**Fig. 9** Mohenjo-Daro. Hollow drum of stupa (Dep. CS. Neg. L. 15002/33, IsMEO, Rome. Photo G. Verardi).



Fig. 10



Fig. 11



Fig. 12

**Fig. 10** Mohenjo-Daro. Monastery. Rooms 46-47-48 (left), 49-50 (centre), 51-52 (right) (Dep. CS. Neg. 15002/29, IsMEO, Rome. Photo G. Verardi).

**Fig. 11** Mohenjo-Daro. Monastery. Room 21 (left), 22 and 23 (centre) (Dep. CS. Neg. 15005/30, IsMEO, Rome. Photo G. Verardi).

**Fig. 12** Mohenjo-Daro. Monastery. Room 27 (Dep. CS. Neg. L. 15005/17, IsMEO, Rome. Photo G. Verardi).



Fig. 13



Fig. 14

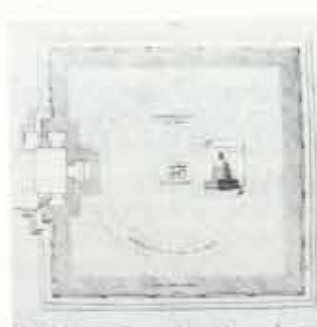


Fig. 15



Fig. 16

**Fig. 13** Conjectural restoration of stupa at Mohenjo-Daro according to Marshall (from Marshall 1931: Fig. 9 p. 116).

**Fig. 14** Stupa at Mirpur Khās (from Cousens 1909-10: Pl. XXX b).

**Fig. 15** Plan of stupa at Mirpur Khās according to Cousens (from Cousens 1909-10: Pl. XXX).

**Fig. 16** Relic chamber of stupa at Sudheran (from Cousens 1929: Fig. 16 p. 103).

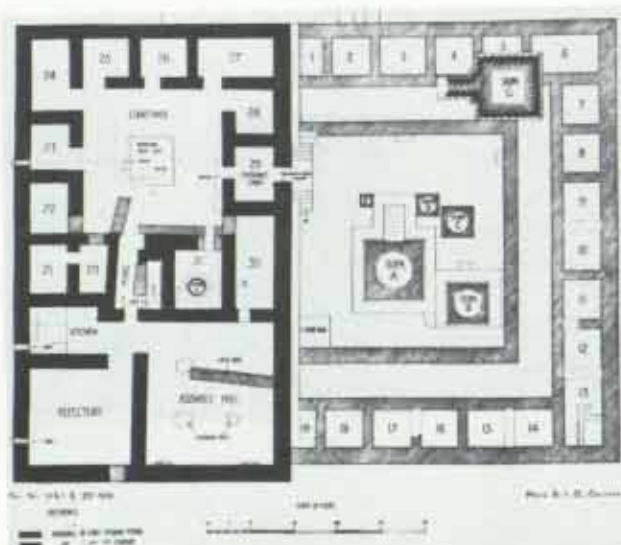


Fig. 17

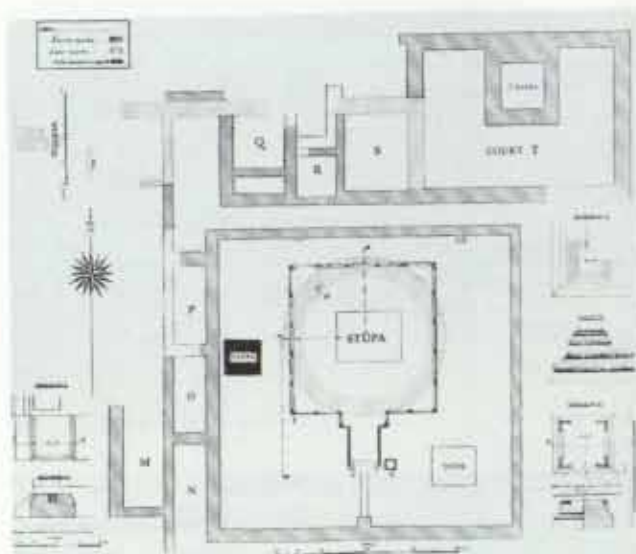


Fig. 18

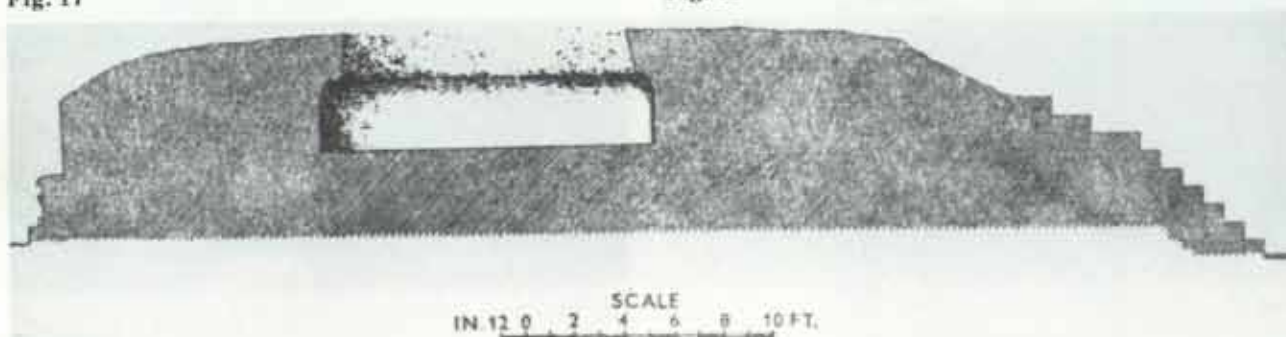


Fig. 19

Fig. 21

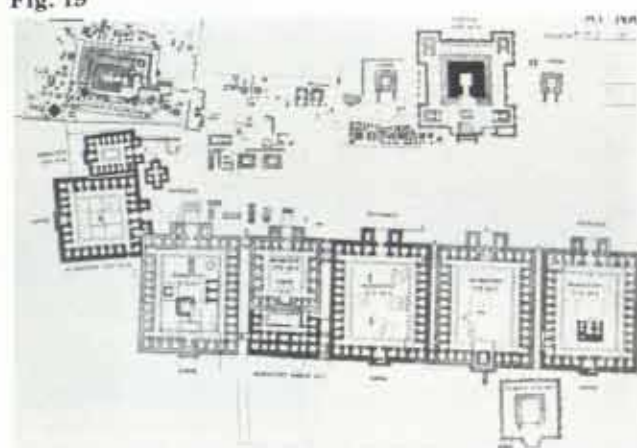


Fig. 20

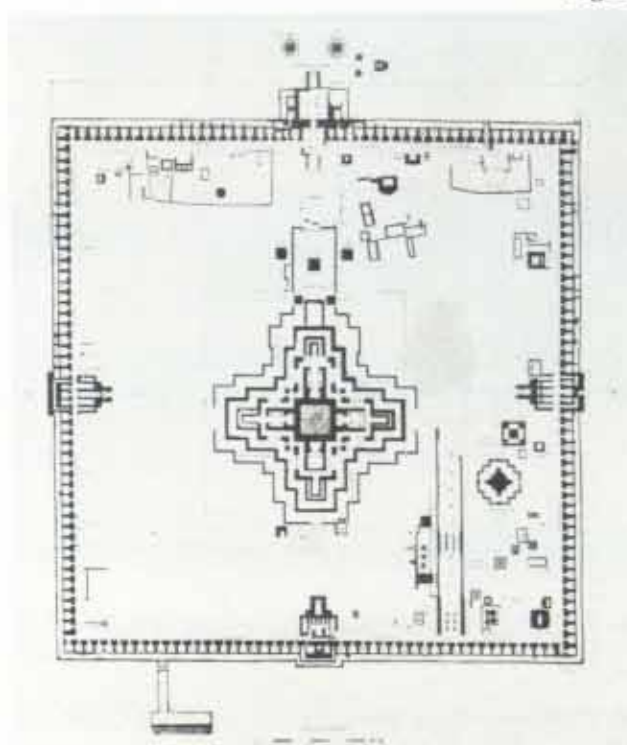


Fig. 17 Pippala (Taxila). Monastery (from Marshall 1951: Pl. 98 a).

Fig. 18 Jandial (Taxila). Stupa and surrounding structures in Mound B (from Marshall 1951: Pl. 91).

Fig. 19 Kālawān (Taxila). Section of stupa A4 (from Marshall 1951: Pl. 73 d).

Fig. 20 Nālandā. Monasteries Nos. 1-8 and 18 (from ASIAR 1930-4: Part 2, Pl. LXXI).

Fig. 21 Paharpur. Stupa compound (from ASIAR 1930-4: Part 2, Pl. XLVII).

# The Theriomorphic Stone Sculpture from Mohenjo-Daro Reconsidered

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Aachen

Today, after more than 60 years of archaeological research at various Harappan sites, we know that Vats was right in hoping to find more stone sculptures, in particular human statues: in the course of further diggings at Mohenjo-Daro a total of 16 stone sculptures were excavated<sup>2</sup> (though not "Sumerian" and mainly fragmentary). Up to the present, this evidence is unique for the settlements of the greater Indus Valley and it might indicate that during a certain period of time Mohenjo-Daro played a major role as an ideological centre within the Harappan realm.

Most of the anthropomorphic stone statues found at Mohenjo-Daro have to be related to the late occupational period of the site.<sup>3</sup> Seven of them, — if the reconstruction of the steatite bust DK 1909<sup>4</sup> is included —, represent half-squatting, half-kneeling males whose statuesque posture, costume, and beard bears a close resemblance to the rendering of eight bearded individuals taking part in a "banquet", a scene depicted on a silver vessel which was rescued from a dealer's shop in the bazaar of Kabul and attributed by Pottier and others<sup>5</sup> to the inventory of Bactrian grave goods dated around the turn of the 3rd millennium B.C.. Whether this "banquet" scene has to be interpreted as purely secular<sup>6</sup> or religious<sup>7</sup> in character is not actually the problematic point here since the representation clearly relates to a ceremony with ideological implications reflecting either an economic (agrarian)<sup>8</sup> or a cultic (religious) background.

It has been suggested that the squatting individuals on the Bactrian silver vessel and the full length anthropomorphic stone sculptures from Mohenjo-Daro should — against the background of their iconographical traits — be regarded as interrelated.<sup>9</sup> Yet this correspondence does not show the particular connotation of the sculptures; the iconographic parallels provide significant clues for the phenomenon of mutual ideological conceptions within the greater Indo-Iranian borderlands which were a result of increasing intercultural contacts at the end of the 3rd, resp. at the beginning of the 2nd millennium B.C..<sup>10</sup>

The theriomorphic sculpture in the round from Mohenjo-Daro appears to be just as significant as the anthropomorphic statues, particularly as this settlement is the only Harappan site where zoomorphic stone sculptures of a larger size have so far been found.<sup>11</sup> These animal images bear certain iconographic characteristics which connect them with other groups of figurative devices from areas outside the basic Harappan sphere.

Four out of a total of five<sup>12</sup> relatively large animal images are of an identical motif: they represent reclining caprids with fore- and hindlegs drawn under the body.

The identification of three of them has been a point of discussion throughout the past decades<sup>13</sup>, as the heads

*"Among the important finds are to be noticed firstly a limestone human headed sphinx of the Babylonian model (VS. 116, Sq. 2200 x 1800, Bs. 2') which is in the round and the first thing of its kind from Mohenjo-daro or Harappa. It gives promise of the possibility of finding human Sumerian figures. Unfortunately its identity owing to break of the front portion is not certain." (Diary of M. S. Vats 10/12/1925)*

When Vats noted these observations down in his diary<sup>1</sup> which he kept during the fieldwork at Mohenjo-Daro, he had indeed made an outstanding archaeological find (Fig. 1) since he had uncovered the first stone statue at a site belonging to the Indus-Civilization.

of the sculptures had been apparently knocked off long before the archaeologists arrived at the site.

With sculpture VS 116 (Fig. 1) Vats in the first instance, believed to have found a "human headed sphinx"<sup>14</sup>, but Mackay corrected this interpretation later by explaining the animal as a ram. (Marshall 1931: 360)

Nevertheless, Vats' presumption of a chimera was to have persistent consequences for the interpretation of further animal sculptures from Mohenjo-Daro: shortly after the first find had been made, two more stone statues of reclining animals were rescued during the same excavation campaign in winter 1925-26 on the "citadel" (SD 1109, Fig. 2) and on Harold Hargreaves' site in the lower town (HR 1072, Fig. 3).

A feature common to both of them is their representation on cubic pedestals firmly connected with them and that they were described by Marshall as "composite creature[s], part bull part ram and part elephant"<sup>15</sup>, an interpretation which seemed to find corroboration through certain fantastic creatures depicted on some of the Harappan steatite seals: "This image" (SD 1109) "calls to mind the curious composite animal represented on seals Nos. 377, 378, 380, and 381, with a ram's body, a human face, elephant's trunk etc. . . ."<sup>16</sup> "In the figure before us the head is badly broken, but there is no doubt about the ram's body and the elephant's trunk, though it is questionable whether it originally had a human head." (Marshall 1931: 360)

A closer examination of the fantastic animals on the seals, however, reveals some crucial differences<sup>17</sup> both within their group as between them and the stone sculptures under discussion:

1. The animals on the seals are portrayed with antlers which either resemble the horns of a Zebu (*Bos indicus*, L.) or those of a Markhor (*Capra falconeri*, Wagner).
2. The bodies of these creatures can not be ascribed to one single and distinct species. Some of them (e.g. E 1277 and HR 4952) show hindpaws and an upstanding slim tail, traits which do suggest physical characteristics of a cat<sup>18</sup>, and others (e.g. VS 1753) portray the shaggy skin of a Balkan sheep (*Ovis strepsiceros*).
3. Most of the chimeras on the seals wear a kind of garland around their necks, a decoration which is absent in the stone statues.
4. The seal creatures are depicted in a standing position, while the statues are rendered in a reclining pose.

These iconographical dissimilarities between the animal representations on the seals and the stone images should not be regarded as accidental and explained as resulting from the artistic licence presumed by the Harappan seal cutters and sculptors. On the contrary, one should expect that the artisans intended to portray different creatures when they represented them in a different manner and with distinctive attributes.

After all, a closer examination of the theriomorphic sculpture from Mohenjo-Daro betrays such a number of corresponding features<sup>19</sup> in subject, composition and working technique that they should be regarded as representations of an identical animal.

While Marshall, Mackay, Mode, Wheeler, and Allchins<sup>20</sup> interpreted the statues, in particular SD 1109 (Fig. 2) and HR 1072 (Fig. 3), as portrayals of fantastic beasts akin to the chimeras on the seals, Fairervis, During-Caspers and Pittman came to the conclusion that the sculptures should be understood as representations of an animal species belonging to the natural environment of the greater Indus Valley.<sup>21</sup> The thickened frontal ridge, a physical trait which had been explained as an elephant's trunk<sup>22</sup> before, was regarded by them as a "stylization of the neck mane" (Pittman 1984: 88) belonging to a natural breed, namely a mouflon (*ibid.*: 88), or a ram (Fairervis 1975: 285; During-Caspers 1986: 302).

The explanation of the ridged appendage as dewlap can in fact now be corroborated by another sculpture fragment of a squatting animal which was recovered as a surface find at Mohenjo-Daro in 1981.<sup>23</sup> Although incomplete, this statue provides valuable information since it is the only figure within this group of sculptures which is not headless (Fig. 4) and might therefore allow identification of the species represented. The image, measuring at present 20 cms in length, 16,5 cms in height and 12,5 cms in breadth, is made out of a yellowish limestone. Despite the weathering of the soft stone which resulted in a shallowing of the carving, it is beyond dispute that a naturalistic creature is represented here and by no means a fantastic being. The dewlap extending down the chest from below the mouth is rendered in an abstract manner, equally the sweeping horns describing an arc of 180 degrees, the drooping, floppy ears<sup>24</sup> and the eyes.

According to the expert judgement of Richard H. Meadow<sup>25</sup> the image represents a so-called Sind Ibex (*Capra aegagrus*, Erxleben or *Capra hircus*, L.), an indigenous species still found today in the mountainous regions of southern Baluchistan from the Makran coast near Pasni to Sind, Kohistan and the Kirthar Range.<sup>26</sup>

In its general composition the sculpture comes very close to VS 116 (Fig. 1), the first find of this kind made by Vats in 1925, particularly as both are shaped in a rather general and abstract manner without an elaborate trimming of the eyes and ears, the neck mane, the ridged horns and hoofed legs.

Apart from this, they have approx. the same dimensions<sup>27</sup> and are both conceived without a base, although it might be possible that they were originally set up on separately manufactured pedestals, as their bottom sides are carefully flattened and smoothed and show no traces of anatomical details.

Unfortunately the hindpart of the image U 81 036 (Fig. 5) is broken off, but from the slight twist of

the head to the right it can be surmised that it was represented in an identical position as the other statues which exhibit a recumbant pose so typical of resting ruminants: their weight is shifted to one side while the hindleg in question is drawn under their hind-quarters.

Image SD 1109 (Fig. 6) is the most elaborate example from Mohenjo-Daro where an illusion of unweight was obtained by hiding the left hindleg under the animal's body and by broadening the right flank of the figure asymmetrically. This tension provokes the perception of a body torsion which is strengthened by a gentle turn of the head to the right.

The photographic documentation of the Sind Volumes<sup>28</sup> has revealed two photographs of sculpture VS 116<sup>29</sup> (Fig. 1, Fig. 7), — each of them taken from the corresponding side —, which despite their poor quality demonstrate that the left hindleg of the animal was not shown (Fig. 1), while the right thigh was rendered in relief (Fig. 7). This artistic device was chosen in order to delude a torsion of the body.

A similar rendering was observed by E. Porada when she described the sculpture of a reclining "mouflon" from Iran, now in the Metropolitan Museum of Art<sup>30</sup>: "die hintere Körperpartie wurde nur auf einer Seite plastisch stärker behandelt, während auf der anderen eine helle Linie im Stein den Umriß des Beines andeutet" (Porada 1974: 163). Whereas E. Porada saw close parallels between this sculpture and mouflon images from Tepe Yahya<sup>31</sup>, H. Pittman<sup>32</sup> related the same sculpture to "those from the Indus Valley" and noted that it was "realistically rendered . . . with the weight thrown fully onto its left haunch, tucking the left hindleg under its body. Although the bottom of the statue is worn away, it is likely that this hidden leg was originally indicated there." (Pittman 1984: 88) In comparison with the animal statues from Mohenjo-Daro, however, it becomes more probable that the left haunch of the Metropolitan Museum's piece was purposely rendered without a pronounced hindleg in order to achieve the illusion of a body torsion.

Another feature noticed by E. Porada actually underlines the affiliation of the Iranian statue to the Harappan sculpture as "the head of the 'mouflon' is separated from the body by a subtle incision" (Porada 1974: 163), exactly as in the images from Mohenjo-Daro (Fig. 2, Fig. 4).

Against the background of these similarities, it can be surmised that the recumbant animal figure from Iran is congenial to the animal sculptures from Mohenjo-Daro, although it is still a problem whether their origin has to be ascribed to the greater Indus Valley or to the Near East.<sup>33</sup>

The artistic device of the body torsion had been observed for the earliest examples from the Near East in a cattle image from the Early Dynastic II Sara-Temple in Tell Agrab<sup>34</sup> and a recumbant animal figurine from the "dépot archaïque" at Susa<sup>35</sup> by

M. Behm-Blancke. He ascribed those two isolated phenomena from the first half of the 3rd millennium to a local workshop tradition concentrated either in the Diyala region (Behm-Blancke 1979: 17) or in the Susiana. (ibid.: 43) For a possible explanation of this phenomenon Behm-Blancke suggested that the torsion motif could have been a result of long distance east-west contacts focussing on the Diyala region during a certain time period, and referred to its cooccurrence in the Harappan Civilization. (Behm-Blancke 1979: 43)

In spite of this conclusive observation, a connection with the subcontinent does not coincide with the comparatively early emergence of the torsion motif in the Susiana and Diyala region with the present chronological background, against which the sculptural art from the Indus Valley has to be seen. And furthermore, we also seem to be confronted with a hiatus of this motif within the Near Eastern art from the first half of the 3rd millennium to the mid of the 2nd half of the 3rd millennium B. C. .

The excavations at Harappa and Mohenjo-Daro have revealed a considerable amount of small amulets (Fig. 8) made of paste, shell and steatite<sup>36</sup> which depict the same type of reclining animals.<sup>37</sup> Some of them even show, when examined from the back, a slight body torsion to the right and the rendering of others clearly shows that the left hindleg was hidden under the left haunch while the right leg was shown more or less in detail.

This characteristic twist, which can also be observed on a bronze figurine of a sitting "goat"<sup>38</sup> originally fixed onto a pin, indicates that they have to be regarded as minute copies of the stone models. Most probably the amulets were worn by Harappans as talismanic charms somehow related to the symbolical meaning of the sculptures. They might have functioned as substitutes for the presumably cultic connotation which the stone images had within Harappan society.

Where and how the stone statues were adored in Mohenjo-Daro is impossible to deduce from what we know of the archaeological record today. All four images seem to have been recovered from a secondary position in "Intermediate" and "Late" Harappan contexts<sup>39</sup>, as they had obviously already been removed from their original settings and demolished while the site was still occupied by Harappans, a sad lot which also befell the anthropomorphic stone statues in Mohenjo-Daro.<sup>40</sup>

Though the stimulus for this "iconoclasm" will in all probability remain a mystery, the destruction of the images might be taken as an indication of an ideological crisis which arose during the last decades of the Harappan Civilization, as a consequence of which the urban social order might have begun to disintegrate and finally collapsed completely.

Albeit, one remarkable feature of two of the images is still evident: HR 1072 (Fig. 3) and SD 1109 (Fig. 2) are represented on a cubic pedestal which is firmly

attached to the sculpture as it is hewn out of the same monolithic block of stone. By means of this artistic device, the animal is not only estranged from its "natural" habitat, but also elevated both physically and symbolically. The pedestal lends the images, despite their modest sizes, an unmistakably monumental quality which underlines their outstanding significance. The geometric base is an elementary vehicle to create distance and momentous value. It directs perception and thus defines a clear esthetic limit between the sculpture and the spectator (adorer?).

These two images are up to the present the only Harappan sculptures which emphasize this particular artistic device. But an observation made by E. During-Caspers provides a further argument for the assumption that the two unpedestalled animal statues from Mohenjo-Daro might have originally been placed on separate bases. In discussing the statue from the Metropolitan Museum of Art referred to above (cf. Porada 1974: 163; Pittman 1984: 88), During-Caspers mentioned "drill hole[s] . . . situated along the . . . flat and polished base . . ." which "can only be explained as a securing device in order to fasten this ram figure onto a pedestal or another support." (During-Caspers 1986: 299). Even if the fragmentary figure 81 U 036 (Fig. 4) from Mohenjo-Daro does not exhibit any drill hole in its bottom side and the original VS 116 (Fig. 1) could not be examined<sup>41</sup>, this still does not exclude the possibility that they had been furnished with drill holes and were both set up on bases.

On the whole, the device of an elevation of the images by means of pedestals on at least two of the statues and the numerous amulett copies suggests an ideological significance of the whole group of recumbent animal portrayals.

Unfortunately, the contents of their symbolical message can not be revealed unequivocally on the basis of our present knowledge from the Indus Valley proper. Should we, as E. During-Caspers had previously proposed, see them in a wider context with two similar animal representations from the well chamber in Diraz on Bahrain? (During-Caspers 1976; 1986)

The findspot of these images close to a well chamber could indeed suggest that they were "connected with a water cult of deep religious significance" (During-Caspers 1976: 17) particularly as "Dilmun", a name so frequently mentioned in the Sumerian cuneiform texts, and commonly related to the "eastern shores of the Persian Gulf" (Kramer 1944: 54) and the island of Bahrain, is a "holy land, a pure and clean place" (ibid.: 55) where the myth of Enki, the great Sumerian water god, and Ninhursag, his spouse, took place, and where temples were "fundamentally associated with fresh water". (Bibby 1986: 194) At an earlier date Bibby had suggested that Enki was originally a Dilmunite god and that later the myth had travelled from there to Mesopotamia. (Bibby 1977: 90)

K. Al Nashef has recently rejected any earlier supposed

worship of the Sumerian pantheon in Dilmun and has pointed out that Near Eastern sources simply referred to a Dilmunite deity pair (Inzag and Meskilak) which was identified by the Sumerians with their main god couple from Eridu, namely Enki and Damgalnuna. (Al Nashef 1986: 348)

Although nowadays we seem to have quite an advanced knowledge of the contacts between the Arabian peninsula, the Sumerian mainland and the Indus Valley proper during the second half of the 3rd millennium B. C., the observations made by Al Nashef actually underline the general problem that cultural (and economical) relations between these countries were obviously of a more complicated nature than presently deducible from the archaeological and textual evidence. It must therefore be taken into account that metaphysical and iconographical ideas travelled from one cultural entity to the other, whilst their basic notions were adapted and/or accommodated to the existing local conceptions. Therefore, partly due to the fragmentary state of workmanship and preservation of the sculptures from Bahrain (During-Caspers 1986: 299, Figs. 119-120), it cannot be ascertained whether these images depicted the identical animal species and corresponding inherent idea as the Harappan sculpture from Mohenjo-Daro. Moreover, they were apparently not designed in the same contorted pose which is so characteristic of the sculptures from the Indus Valley and the isolated find from Iran.

But in order to bring more fantasy into the speculation of a worship concerning the Sumerian water god, an interesting iconographical feature of the Near Eastern glyptic art should be mentioned: Enki, who is commonly depicted with two riverstreams flowing out of his shoulders or a vessel held in his hands, is sometimes also illustrated while "his foot may rest on an ibex, emblem of sweet underground springs, the Apsu." (Jacobsen 1976: 111)

As W. Hartner has pointed out, the recognition of star configurations on the Sumerian horizon might have led to an early correlation of the stellar signs with gods, — personified in human or animal shape —, who were responsible for the cosmic and worldly order.

A recognition of the regular movements of at first sight apparently confuse and abstract star constellations, which on the other hand obviously influenced seasonal changes in nature (spring, summer, autumn and winter) might indeed have led to an assimilation of these curiosities to human fantasy and mythological thought. Metaphorical images, animals and human beings, finally gods, were thus associated with the stellar constellations, which became responsible for the laws of nature and mankind as incarnations of the celestial phenomena.

The constellation of "the classical Aquarius ("Water Carrier")" can iconographically "be traced back to Sumerian times as one of the particularly favoured symbols, representing a male deity, often standing on

top of the Sacred Mountain, and pouring water from two vases". (Hartner 1965: 9) But, as W. Hartner has argued, it might have had its origins in iconographical representations depicting "the Ibex or Mouflon, which comprised in all probability all the main stars both of Capricorn and Aquarius", which "was actually the zodiacal constellation indicating by its heliacal rising the Winter solstice or a date close to it." (ibid.: 9)

In the following Hartner resumed Near Eastern iconographical motifs representing animal combats<sup>42</sup> which, according to his arguments, have to be seen as illustrative embodiments, artistically and ideologically transformed conceptions concerning celestial events, which periodically appeared on the Sumerian horizon. The constant reoccurrence of these iconographical themes throughout centuries<sup>43</sup> was thus interpreted as giving witness to the ideological significance celestial and successive seasonal changes had within human perception and mythological thought. But should we assume that the Sumerian conceptions of astral events, persistent as they obviously were<sup>44</sup>, were also known to the people of the Harappan Civilization?

It would definitely go far beyond the scope of this paper and our present knowledge to exemplify possible, but mostly hidden and very scanty indicators for connections within the ideology of Near Eastern, Dilmunite and finally the greater Indus Valley areas.

What we believe to know of the subcontinent for the period of the second half of the 3rd millennium is that the Harappans were apparently devoted to some kind of water cult<sup>45</sup> and that they were acquainted with an orientation system which was sophisticated enough to presume stellar observations.<sup>46</sup>

This, however, does not yet permit the assumption of close connections with the ideological conceptions prevailing in the Near East. We are still faced with the problem that we can hardly discern the dimensions of intercultural relationships between the peoples of the late 3rd millennium B.C., though mutual contacts have to be regarded as certain.

Another interesting phenomenon is the frequent artistic representation of reclining or erect ibexes in the Bronze Age cultures of Turkmenia and Bactria. They are most common as decorations on metal pins which were used as cosmetic utensils or hair and garment pins. The seated animals are shaped in an almost identical posture as the stone images, sitting on a tiny base and turning their heads to the right. The same kind of metal pins have been known for a long time from Near Eastern sites such as e. g. Kish, Chagar-Bazar and the Susiana plain, and again a hiatus of approx. 1000 years between them and the Bactrian specimens remains a puzzling problem.

Moreover, protomes of mountain goats frequently adorn cosmetic bottles rescued from Bactrian graves and standing or reclining animals of the same type

were a very popular motif in Bactrian glyptic art, all dated around 2000 B.C.. Although the appearance of the mountain goat on cosmetic utensils might be an indicator for a purely decorative significance<sup>47</sup> of this animal, its frequent occurrence on the seals also makes a symbolic connotation possible.

Against the background of the knowledge we have of the Indo-Bactrian connection, it is very likely that the image of the ibex or mountain goat had a similar ideological meaning in both of the cultural entities, and that this phenomenon was finally a result of the complex relationships between the civilizations from the Arabian peninsular to the subcontinent from centuries ago.

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My special gratitude shall be expressed to the German Volkswagen Foundation who supported my studies in Germany and Pakistan for thirty months.

This paper would not have been written without the keen observation of Hans Ulrich Uebecke, who detected the fragmentary stone image 81 U 036 on the surface at Mohenjo-Daro.

I have to thank the former Director General of the Department of Archaeology and Museums, Government of Pakistan, Mr. M. Ishtiaq Khan and the Deputy Director Mr. Kurshid Hasan for their generous support during many years of research in Pakistan.

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## Footnotes

- 1 Courtesy of the Department of Archaeology and Museums, Government of Pakistan, Karachi
- 2 Eleven of these fragments belong to a certain type of anthropomorphic statue, namely HR 163, HR 910, HR 5785, L 898, L 127, SD 624, SD 2781, DK 1909, DK 4647, DK 1419, DK-B 1057 (see: *Ardeleanu-Jansen* 1984: 139-157) while five other fragments represent zoomorphic sculptures: VS 116, HR 1072, SD 1109, SD 2722, and U 81 036.
- 3 *Ardeleanu-Jansen* 1984: 154
- 4 *Ardeleanu-Jansen* 1984: 154, Fig. 40
- 5 *Deshayes* 1977: 104-5; *Amiet* 1983: 26; *Pottier* 1984: 73-74
- 6 *Amiet* 1983: 26; *Amiet* 1986: 203-204
- 7 *Pottier* 1984: 73-74
- 8 see FN 6
- 9 *Amiet* 1986: 203; *Ardeleanu-Jansen* 1987: 176. Although Amiet's interpretation argues from a different notion, he comes to the conclusion that the small squatting chlorite statue found at Susa (*Amiet* 1986: fig. 108) shows strong iconographic similarities to the male persons represented on the above mentioned Bactrian silver vessel and to one human stone sculpture from Mohenjo-Daro (L 950, *Marshall* 1931: Pl. C, 1-3). His observations might be taken as a support for my conviction that the human full length statues from Mohenjo-Daro have to be seen in relation to the Bactrian representations.
- 10 *Jarrige, J.-F.* 1987: 109-111
- 11 A stone image of a reclining animal has been found at Kalibangan. It is also headless and from the yet unpublished photograph it is not ascertainable whether this image belongs to the same category of sculptures under discussion.
- 12 The fragmentary cattle image found on the "citadel" at Mohenjo-Daro (SD 2722, *Mackay* 1938: Pl. LXXI, 25) does not belong to this group of sculptures under discussion. It has been dealt with previously, I refer to my contribution "A Short Note on a Steatite Sculpture Fragment from Mohenjo-Daro" for SAA 1985, in: *K. Frifelt* (ed.), Aarhus, in press
- 13 E. g. *Marshall* 1931: 360; *Mode* 1944: 64; *Wheeler* 1968: 88; *Fairservis* 1975: 285; *Allchin & Allchin* 1982: 204; *Pittman* 1984: 88; *During-Caspers* 1976; *During-Caspers* 1986: 302
- 14 See supra: entry in Vats' diary from 10-12-1925
- 15 For SD 1109 see ARASI 1925-25: 80, and *Marshall* 1931: 150; for HR 1072 see ARASI 1925-26: 85 "White limestone pedestal with an image of seated composite animal. Head broken. The image is similar to the one found in SD area (compare page 80 above). It has the body of a bull, the head of a ram and the trunk of an elephant." and *Marshall* 1931: 181, 360.
- 16 Similar fantasy creatures were published in the second monograph on Mohenjo-Daro by *Mackay* 1938: Pl. LXXXVII, 258 = DK 12194; Pl. XCIV, 411 = DK 5307; Pl. XCV, 450 = DK 6658; Pl. XCVI, 493 = DK 8248 or DK 8253; Pl. XCVI, 521 = DK 5935; Pl. CVIII, 636 = DK 8519.
- 17 Already hinted at by *During-Caspers*. (*During-Caspers* 1986: 302)
- 18 Possibly a tiger? See *Marshall* 1931: 389
- 19 "... certain details appear common to all three pieces of statuary." (*During-Caspers* 1985: 423)
- 20 *Marshall* in ARASI 1925-25: 80, 85; *Mackay* in *Marshall* 1931: 360; *Mode* 1944: 64; *Wheeler* 1968: 88; *Allchin, B. & F. R.* 1982: 204
- 21 *Fairservis* 1975: 285; *During-Caspers* 1986: 302; *Pittman* 1984: 88
- 22 *Marshall* in ARASI 1925-26: 80; *Mackay* in *Marshall* 1931: 360; *Mode* 1944: 64; *Wheeler* 1968: 88; *Allchin, B. & F. R.* 1982: 204
- 23 The stone image was discovered by M. Uebecke, then member of the "German Research Project Mohenjo-Daro" mission to Mohenjo-Daro, in the southern area of VS A.
- 24 This typical rendering of the ears was actually misunderstood by E. *During-Caspers* when she discussed the figure SD 1109 and contemplated whether this "small dependent loop" should be regarded as an eye. Although she deemed that it was too "wrongly shaped and angled for a natural eye", her supposition that "it appears too small and ill-situated to represent an ear" (*During-Caspers* 1985: 425) can now be rejected, as it is obviously meant to represent the ear of sculpture 81 U 036.
- 25 Personal communication with R. H. Meadow
- 26 *Roberts* 1977: 190
- 27 VS 116 is approx. 17,8 cms high and 33 cms long while 81 U 036 is in its present condition ca. 16,5 cms high and ca. 20 cms long, indicating that it originally must have had approx. the same length as VS 116.
- 28 Courtesy of the Department of Archaeology and Museums, Government of Pakistan, Karachi, and the Archaeological Survey of India, New Delhi.
- 29 The whereabouts of the original image could, up to the present day, not be traced by authoress.
- 30 According to Pittman's information "recently acquired from an old American collection" ... (*Pittman* 1984: 88)
- 31 PKG Bd. 13, 1974: Abb. 68a-c
- 32 I am indebted to Paul Yule, Bonn, who drew my attention to Mrs. Pittman's publication.
- 33 According to Pittman "the Mohenjo Daro pieces" are "fine examples of ancient Near Eastern sculpture." (*Pittman* 1984: 88)
- 34 *Behm-Blanke* 1979: 17, Nr. 100, Abb. 27a-c (Ag 35: 880)
- 35 *Behm-Blanke* 1979: 18, Nr. 107, Taf. 9, 50a,b (Sb 110)

- 36 Some rare examples are worked in bronze, compare Mackay 1938: Pl. LXXVII, 15 = DK 4091
- 37 An observation already made by M. S. Vats (Vats 1940: 305) and H. Pittman (Pittman 1984: 99 FN 14). The published examples are to be found in: Marshall 1931: Pl. XCVII, 1 = HR 2013; 2 = SD 2278; 3 = VS 2046; 5 = SD 2278; Mackay 1938: Pl. LXXIV, 6 = DK 11 229; Pl. LXXVII, 8 = DK 10 303; 9 = DK 12 858; 13 = DK 4566; 15 = DK 4091; and Vats 1940: Pl. LXXVIII, 42 = 8766; 43; 44 = Ab616; 45 = 11458
- 38 DK 10 781 AC (Mackay 1938: Pl. LXXIV, 18-19)
- 39 According to the excavators' descriptions VS 116 was found at 2 feet below surface in a context called "Intermediate", HR 1057 came from -2 feet in House III in HR-A area designated as a structure of the "Intermediate" period and SD 1109 lay at 3 feet below the surface in an area dated "Late". (Marshall 1931: 360) 81 U 036, finally, was recovered from the surface in VS-A area.
- 40 Ardeleanu-Jansen 1984: 154
- 41 see FN 29
- 42 E. g. the lion-bull combat, referring to the celestial constellation of Leo and Taurus, "had originally an astronomical meaning and symbolized a well-defined calendrical event (a solar date);" (Hartner 1965: 3)
- 43 From the beginning of the third millennium B.C. up to the first millennium B.C..
- 44 Our contemporary zodiacal constellations are based on helenistic traditions which go back to Seleucid texts referring to much older observations mentioned in the "mul Apin" series of Babylonian times.
- 45 Marshall 1931: 75; Miller 1985: 50; Jansen 1987: 155
- 46 See Maula 1984 in: Jansen/Urban (eds.) Interim Reports Vol. I: 159-170 and Wanzke this volume.
- 47 Sarianidi 1986: 183

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**Fig. 1**



**Fig. 3**

**Fig. 1** VS 116 (Museum: unknown) H.: ca. 17,8 cm; L.: ca. 33 cm  
(photo: Sind Volume IX 1925-26, 3665)

**Fig. 2** SD 1109 (MM\* 430) H.: 25,5 cm; L.: 19,5 cm; B.: 13 cm  
(photo: Georg Helmes, Aachen)

**Fig. 3** HR 1072 (Museum: unknown) H.: ca. 21,3 cm;  
L.: ca. 16,3 cm; B.: ca. 10,2 cm  
(photo: Sind Volume VIII 1925-26, 339)

**Fig. 4** U 81 036 (MM\* 5695) H.: 16,5 cm; L.: 22 cm; B.: 12,3 cm  
(photo: Georg Helmes, Aachen)



**Fig. 2**

**Fig. 4**





Fig. 5



Fig. 6

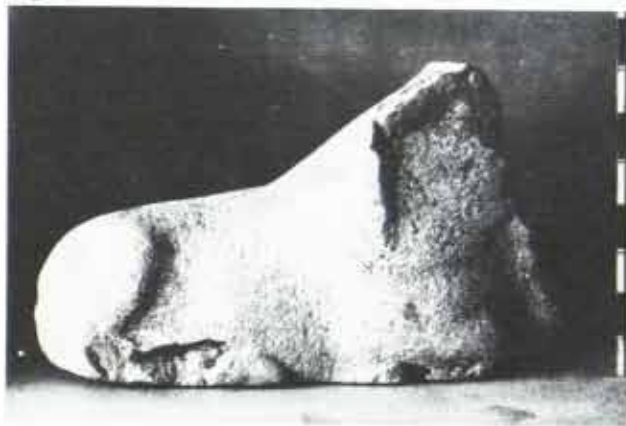


Fig. 7



Fig. 8

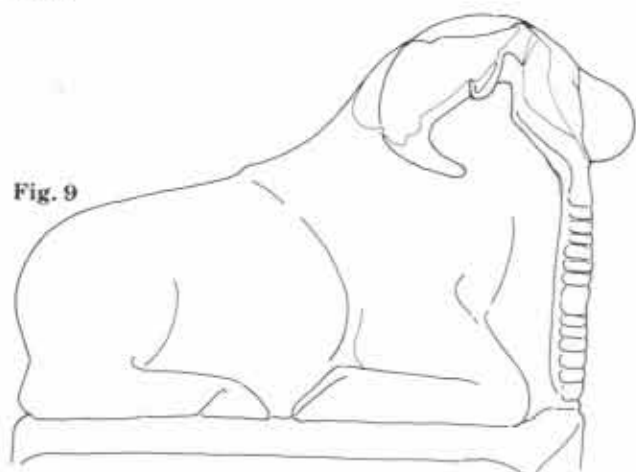


Fig. 9

Fig. 5 U 81 036 (MM\* 5695)

Fig. 6 SD 1109 (MM\* 430) (photo: Georg Helmes, Aachen)

Fig. 7 VS 116 (Museum: unknown) (photo: Sind Volume VII 1925-26, 281)

Fig. 8 DK 4865 (NMK\* 52.3205) H.: 1,6 cm; L.: 2,5 cm; B.: 1,1 cm (photo: Georg Helmes, Aachen)

Fig. 9 SD 1109 (MM\* 430) (drawing: Rolf Bunse, Aachen)

\* MM = Mohenjo-Daro Museum

\* NMK = National Museum, Karachi

## A New Copper Tablet from Mohenjo-daro (DK 11307)\*

Paul Yule,  
Bochum

To the incunabula of the Harappan script belongs a hitherto unrecognized depiction scratched into a rectangular reddish "copper" tablet on deposit in the Study Collection of the Archaeological Survey of India in Delhi (Fig. 1). Despite its striking character, this representation has been neglected by specialists generally preoccupied with the problems of decipherment. For whatever reason, the tablet did not appear in E. J. H. Mackay's excavation report of 1938 for Mohenjo-daro, from where it was excavated in 1931. Rather, it remained almost unnoticed until B. M. Pande sketched it for preliminary publication in 1973.<sup>1</sup>

The exact findspot of the tablet is problematic. On its reverse side, the excavation number and inventory

number of the Purana Qila Study Collection (SC 63.10/262) appear in white paint. According to the fieldbook of the excavation, the tablet came to light in room 327 of the DK-G area<sup>2</sup>, and lay at a depth of 2.68 m below datum, which the excavator assigned to his Late Period II. But neither the block, house, nor the room of the preliminary numbered room 327 are identifiable in the final plan. Thus, the location and nature of the find context remain obscure. Nor are the associated finds of help in determining the original use of the architectural structure or of the tablet itself.<sup>3</sup>

As often the case with such tablets, the surface of the metal has suffered from abrasive cleaning. Following the restoration, chalk was rubbed into the incisions in order to make the motif more readily visible. On the obverse the position of the hooves, legs and the drawing of the shoulders leave little doubt as to the iconography. Two front halves of conjoined bovids point respectively to the left and right. Moreover, flanking this phantastic creature are two "altars"<sup>4</sup> which otherwise only appear in front of the creatures depicted on Harappan seals and copper tablets. The right head is well-preserved. Visible are horns, ears, and vertical stripes, as in the case of the unicorns which appear on Harappan sealstones.<sup>5</sup> The head on the left is badly damaged, but visible are a horn, the lower contour of the jaw and vertical stripes across the face, similar to those of the head right. The appearance of this motif becomes clearer when held in the hand than is evident from even excellent photographs. Clearly we are not dealing with a recut tablet; other depictions on copper tablets also show creatures with heads in front in the normal position, and emerging from behind as well.<sup>6</sup>

The reverse is more difficult to make out than the obverse, but the four signs are intact and legible, although at certain points only as slight imprints.

The inscription associated on copper tablets with a different kind of bull, the short-horned bull<sup>7</sup>, differs from our inscription, and we may be dealing with two different deities, each having its own name.

A. Parpola has remarked that the figural representation suggests a dichotomy such as day and night, or summer and winter, in order to explain the iconology.<sup>8</sup>

In fact, the double animal motif is by no means unique to the Harappan Culture, but also occurs in neighbouring areas.<sup>9</sup>

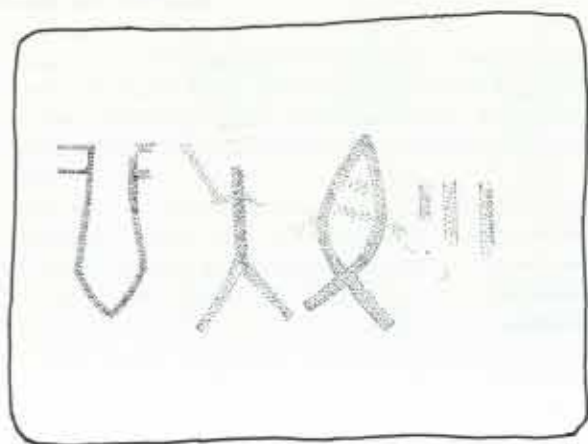
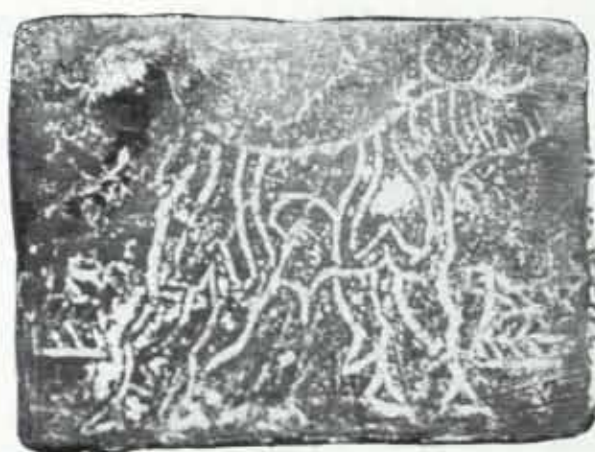
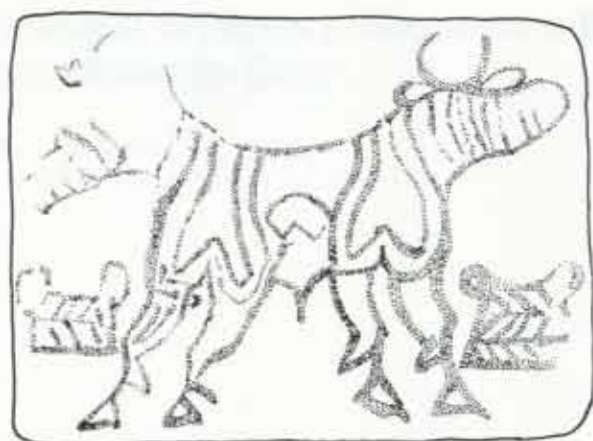
From a recent recording and study of all Harappan copper tablets (142 reasonably preserved examples), the piece under discussion shows a new pictorial type. It is one of a number of unpublished metallic artifacts which demonstrate that the extant Harappan objects are less stereotyped and repetitive than one might surmise on the basis of the *prima facie* materials from Chanhudaro, Harappa, Mohenjo-daro and other sites.

# Footnotes

\* I should like to thank Dr. Debala Mitra, Director General of the Archaeological Survey of India at the time of my campaign in 1982, for permission to record and publish the tablet presented here, and for supporting our Corpus of Prehistoric South Asian Metal Objects.

Shri R. P. Sharma, at the Study Collection, was particularly helpful. The tablet under consideration measures 3.86 x 2.87 x 0.22 cm. Few Harappan metal artifacts have been analyzed in order to determine their constituent elements (no tablets have been analyzed), but the material of our piece is probably copper, at least to judge from the colour. Although there is room for doubt as to the metal, I retain the term "copper" for reasons of economy. With regard to the identification of copper and bronze see Yule, *Harappazeitliche Metallgefäße in Pakistan und Nordwestindien. Prähistorische Bronzefunde II*, 7 (Munich 1985) 22-23 note 17 (= PBF). Lastly, Prof. Asko Parpola kindly criticized the text.

- 1 S. Koskeniemi/S. Parpola/A. Parpola, *Materials for the Study of the Indus Script* (Helsinki 1973) inscription number 030272042. B. M. Pande, "Inscribed Copper Tablets from Mohenjo-daro: A Preliminary Analysis." D. Agrawal/A. Ghosh (eds.), *Radiocarbon and Indian Archaeology* (Bombay 1973) tablet no. 38. Pande verifies the museum inventory number with the excavation number. Cf. Yule, *Figuren, Schmuckformen und Täfelchen der Harappa-Kultur. PBF I*, 6 (Munich 1985, 4, no. 47, 415.)
- 2 I thank Alexandra Ardeleanu-Jansen for this information (letter 14.05.85). Further work on the reconstruction of the excavation and finds by her may clarify the provenance.
- 3 An alabaster dish (DK 11306) was the only other object accompanying the tablet. (ibid.)
- 4 Pande's sketch (supra note 1) is very cursory. It omits all details, the "altar", and the traces of the head on the left, the ears on the head on the right, to mention the most obvious exclusions.
- 5 Cf. Sir John Marshall, *Mohenjo-Daro and the Indus Civilization* (London 1931) Pl. CIII; Sir Mortimer Wheeler, *The Indus Civilization* (Cambridge 1968) Pl. 27.
- 6 Cf. Yule, *PBF I*, 6 nos. 460-466, 469.
- 7 The Finnish team has equated our bicorporate with the short-horned bull. S. Koskeniemi/S. Parpola/A. Parpola, *Materials for the Study of the Indus Script*; A. Parpola, "Tasks, Methods and Results in the Study of the Indus Script." *JourRoyAsSoc* 1975, 2, 197. Short-horned bulls: Yule, *PBF I*, 6 Nos. 412 and 413.
- 8 Personal communication.
- 9 Cf. R. von Heine-Geldern, "New Light on the Aryan Migration to India" (1937). R. von Heine-Geldern *gesammelte Schriften. Acta Ethnologia et Linguistica* (Vienna 1983) 155-167 fig. 5a-c: from T. Hissar IIIC, Kedabeg Kalakent (Early Iron Age), and from Transcaucasia (no context); P. Amiet, *Collection David-Weill. Les antiquités du Luristan* (Paris 1976) 67-68 fig. 43, no. 138. I thank M. Bemmman for these citations. Cf. also K. Pischelauri, *Jungbronzezeitliche bis ältereisenzeitliche Heiligtümer in Ost-Georgien. AVA Materialien 12* (Munich 1984) 54 fig. 30, 15-29 from Silda (2nd half of the 2nd mill.).



DK 11307

Fig. 1 "Copper" tablet DK 11307 (SC 63.10/262).



# Chemical Analysis of Stoneware Bangles and Related Material from Mohenjo-Daro

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## Materials and Methods

This paper presents preliminary results of a study of stoneware bangles from Mohenjo-Daro (Franke 1984), their raw materials and manufacturing technique and their relationship to other ceramic materials from this site.

Starting with the investigation of a single fragment of a stoneware bangle from Mohenjo-Daro (Schneider/Büsch 1984), 28 new samples were analysed for a more generalized view (Table 1). The new series included fragments of bangles with oval, irregular triangular and round cross-sections and of varying colour, samples from coated sub-cylindrical bowls which were probably used in the manufacture of the bangles (Halim/Vidale 1984: 93), other samples from coated carinated jars, from potsherds and from a terracotta fragment from Mohenjo-Daro. A clay sample from a recent potter's workshop in a village nearby was analysed for comparison purposes. The investigation was conducted in cooperation with Ute Franke and the German Research Project Mohenjo-Daro.

The analyses were carried out by wavelength dispersive x-ray fluorescence (Philips PW 1400). One gram of a powdered sample is mixed with four grams of a flux (Merck Spectromelt A 12) and melted to produce a glass disc for automatic measurement. The calibration is based on forty international geochemical standards and on interlaboratory tests for pottery analysis. The elemental compositions (Table 2) are given on a basis of ignited samples (950° C) for easier comparison.

## Results

The composition of the analysed bangles shows only very little variation. It corresponds to a calcareous clay with a high amount of flux: iron, calcium, potassium and sodium.

There is no indication of any admixture of other materials (e.g. iron oxides, feldspar) as is shown by comparison with the composition of clay samples

(Table 2: 2953, 3297). There is no essential difference in composition between bangles of different shape or firing conditions, if the valence state of iron is not taken into consideration. That means that the same raw materials were used. The potassium and rubidium values of the oval-type bangles are a little bit higher than those of the round-type bangles. This can only be recognized due to the extreme homogeneity of composition of these groups and could be interpreted as an indication of a slightly different clay source. However, more samples are needed to prove this difference.

Some bangles contain significantly higher amounts of sodium. Three of these are red unpainted bangles with round cross-sections. They are more similar in composition to the pottery group. The higher ignition losses of the bangles with higher sodium content could be an indication of secondary compositional changes due to contamination in the ground. This is supported by the fact that the samples with the highest ignition losses have significant amounts of sulphur up to 0.5% (in 2949). If this was added as sodium sulphate it would result in a Na<sub>2</sub>O value which is higher by 1%. The modern clay sample contains about 0.1% sulphur, whereas all other materials show only traces.

Coated sub-cylindrical bowls, coated carinated jars, pottery and terracotta from Mohenjo-Daro analysed are similar in material composition to the bangles and are very probably made from a clay of the same origin. Minor differences in calcium content allow a grouping of these materials. Because of the small number of samples such groupings are only preliminary and remain to be proved by new analyses of more samples.

One sample of a coated sub-cylindrical bowl (2940) has a composition identical to that of the bangles. A second sample (2941), however, is different through higher amounts of calcium (and strontium) and lower amounts of potassium, aluminium and iron which could be explained as due to a less fine levigation of the original clay. The analyses of coated carinated jars represent a different compositional group containing less calcium (iron, manganese, magnesium and strontium) and higher amounts of silica, sodium (and zirconium). A sample of a pointed-base goblet (2942) as well as two potsherds and a terracotta fragment are very similar to the latter group. This group of pottery, terracotta, coated carinated jars and the simple round-shaped bangles, in contrast to the composition of the majority of the bangles, has a much larger compositional variation. This could be explained by a less thorough preparation of the raw materials.

By comparison with the modern potter's clay (2953) and the alluvial sediment (3297) which are very similar

in their main and trace element composition, it can be shown that the raw materials were available in the Mohenjo-Daro region. This conclusion is supported by five previous analyses of bricks (Ludwig 1983: 156) and vitrified kiln materials (Gussone 1983: 168) which show a similar composition and very likely were also made from local clays. Microscopic studies of thin sections confirm the results obtained from chemical analysis. The material used for the bangles was levigated very finely and, with a few exceptions, does not contain grains larger than about 20  $\mu$ , whereas the other materials include grains of quartz and feldspar (plagioclase) up to 60  $\mu$  (and sometimes larger). This is also true for the clay used by the potters in Hassan Wahan, which is suitable for reconstruction experiments because of its mineralogical and chemical similarity.

Ignition losses of the bangles and pottery samples are generally low, indicating high original firing temperatures. Because of an initial firing in a reducing atmosphere ignition losses can even be negative due to the oxidation of Fe(II) to Fe(III). As a result of this oxidation the weight increases by about 0.8% and thus reduces the decrease which is caused by the evaporation of water. This is true for the grey samples whereas the red materials were fired in an oxidizing atmosphere. Firing in an oxidizing atmosphere results in a lower degree of vitrification even when the same temperature is applied, due to the Fe(III) which is not as good a flux as Fe(II). This is evident from the examination of round-shaped bangles in the scanning electron microscope showing increasing stages of vitrification (Fig. 1 to 4). A red-coloured bangle represents the lowest vitrification stage. Pale brown mottled surfaces derive from a later oxidizing of Fe(II) due to corrosion. This weathering layer can also be seen on broken surfaces of bangle fragments.

The water-absorbing capacity of fragments is less than 1.5%. Therefore this material is classified as a stoneware. It is higher only in red-coloured bangles with round-cross sections. Hardness of the grey bangles is between Mohs 6 and 7. The material is thus harder than steel or glass.

The technologically outstanding ceramic material is very similar to the so-called "Böttgersteinzeug". This

was invented about 1709 A.D. in the course of trying to produce porcelain in Europe. Because of its hardness and its fine texture it can be ground like semi-precious stones. The comparison of the Mohenjo-Daro bangles with an original sample of "Böttgersteinzeug" shows a textural correspondance under the microscope. The latter material also contains grains of quartz up to 20  $\mu$ , but in a larger amount and it shows a similar degree of vitrification. Since it is made from an uncalcerous clay (Table 2: 3249 and 3250) it needs a higher firing temperature.

## Conclusions

All stoneware bangles from Mohenjo-Daro investigated here were made from a very finely levigated clay which is similar in composition to a clay still used today by potters in a nearby village. This is true for bangles of different shapes and colours. The same material was used for coating sub-cylindrical bowls. The coated carinated jars as well as pottery and terracotta were also made from a very fine clay, but slightly different in composition. From this we may conclude that bangles and pottery were made in different workshops, because we would expect a higher dissimilarity between two materials prepared for different purposes in the same workshop.

The grey bangles were fired in a reducing atmosphere between 1000° and 1100°C. To do this the best way would have been firing in ceramic containers as described by Halim and Vidale 1984. The red-coloured bangles were fired in an oxidizing atmosphere, therefore this could not have been done in containers. These bangles are less vitrified. Further investigations into the method of manufacture are in progress.

From the point of view of the material's science the Mohenjo-Daro bangles represent a very advanced stage of ceramic technology. In Europe a similar material was reinvented about 4000 years later. Apart from a special kind of pottery from the first half of the 3rd millenium B.C. which is found in NE-Syria and SE-Turkey the stoneware bangles from Mohenjo-Daro represent the earliest known artefacts of real stoneware.

Table 1

List of investigated samples. The samples derive from private collections. Colours are given for freshly broken surfaces if not otherwise specified, symbols according to Munsell Soil Colour Chart.

Fragments of bangles with oval or irregular triangular cross-sections

1987	very dark grey (10YR3/1)
2930	dark grey (7.5YR4/1), surface colour pale brown (10YR6/3)
2931	dark grey
2932	grey
2933	grey
2934	dark grey, surface colour pale brown mottled
2935	dark grey, surface colour pale brown mottled
2936	dark grey, surface colour pale brown mottled
2937	dark greyish-brown (10YR4/2)

# Fragments of bangles with round cross sections, painted

2943	grey, 15 mm thick, painted line reddish brown
2944	dark grey, 15 mm thick, painted line reddish brown
2945	grey, 10 mm thick, surface colour pale brown with reddish brown painted line
2946	very dark grey, 12 to 15 mm thick, irregular round, painted line dark brown
2947	yellowish red (5YR4/6 to 5/8), 15 mm thick, painted line dark reddish brown (2.5YR3/4)
3298	yellowish red, 16 mm thick, painted line dark reddish brown

# Fragments of simple, rounded bangles

2948	yellowish red
2949	yellowish red
3299	yellowish red, 9 mm thick

# Other materials from Mohenjo-Daro

2940	body fragment of a coated sub-cylindrical bowl, 4 to 5 mm thick, dark grey
2941	base fragment of a coated sub-cylindrical bowl, 4 mm thick, grey
2938	body fragment of a coated carinated jar, inner layer (a) and outer chaff-tempered layer (b)
2939	layered fragment of a coated carinated jar, 25 mm thick
2942	body fragment of an overfired pointed base goblet
2950	yellowish red coloured potsherd
3296	potsherd of black on red ware
2954	fragment of a terracotta
2953	unfired potsherds from a potter in Hassan Wahan
3297	alluvial sediment of the river Indus

# Later material equivalents (from S. Bursche, Berlin)

3949	sample of original "Böttgersteinzeug" of 1710 A.D., dark reddish brown (2.5YR2.5/4)
3950	sample of modern "Böttgersteinzeug"

**Table 2**

Chemical composition of samples determined by X-ray fluorescence

Main element oxide content (% by wt.)

	SiO <sub>2</sub>	TiO <sub>2</sub>	Al <sub>2</sub> O <sub>3</sub>	Fe <sub>2</sub> O <sub>3</sub>	MnO	MgO	CaO	Na <sub>2</sub> O	K <sub>2</sub> O	P <sub>2</sub> O <sub>5</sub>	ign. loss	SUM*
1987	54.14	.903	18.64	8.14	.126	4.06	9.17	.97	3.43	.156	-.45	100.32
2930	54.09	.916	18.36	8.61	.142	3.99	9.41	.95	3.37	.156	-.50	95.51
2931	54.69	.907	19.13	8.49	.122	3.96	8.31	.81	3.42	.157	.02	98.90
2932	55.05	.903	19.37	8.30	.109	3.90	7.95	.80	3.46	.155	-.41	99.01
2933	54.47	.903	18.71	8.39	.155	3.93	8.78	.96	3.60	.152	-.39	98.99
2934	54.58	.903	18.93	8.45	.119	3.89	8.54	.88	3.56	.151	-.42	98.30
2935	54.45	.908	18.79	8.48	.125	4.09	8.76	.84	3.41	.151	-.47	99.01
2936	54.72	.903	19.22	8.50	.117	3.84	8.10	.87	3.58	.153	-.39	99.66
2937	54.26	.905	18.79	8.45	.120	3.77	8.58	1.58	3.36	.187	.71	98.50
2943	54.46	.907	19.10	8.55	.131	3.97	8.57	.91	3.26	.147	.49	99.37
2944	54.81	.914	18.67	8.47	.140	3.89	8.76	.88	3.31	.156	-.14	98.91
2945	54.71	.904	18.56	8.38	.131	4.06	8.82	.98	3.27	.156	-.31	98.96
2946	54.62	.903	19.05	8.51	.126	4.28	8.04	.98	3.35	.145	.02	98.15
2947	54.93	.905	19.07	8.49	.126	3.88	8.30	.99	3.14	.179	.90	99.09
3298	54.35	.910	19.82	8.66	.132	3.65	8.08	1.02	3.24	.153	0.97	100.40
2948	56.55	.897	18.57	8.26	.124	3.75	6.74	1.37	3.55	.180	1.03	98.64
2949	55.15	.862	18.19	7.99	.117	3.62	7.01	2.90	3.93	.221	2.29	98.24
3299	57.99	.844	18.17	7.69	.103	3.60	6.42	1.72	3.31	.210	2.38	99.41
2940	54.55	.908	18.57	8.38	.132	3.81	9.40	.88	3.22	.149	-.30	100.17
2941	57.76	.830	16.47	6.71	.115	4.34	10.69	.95	1.99	.155	.32	99.12
2938a	58.91	.876	18.60	8.03	.105	3.46	5.08	1.33	3.41	.198	.64	98.19
2938b	58.76	.866	18.45	7.91	.103	3.46	5.41	1.32	3.51	.219	1.53	99.82
2939	58.83	.874	18.40	7.94	.105	3.43	5.32	1.43	3.49	.184	.53	97.48
2942	58.68	.812	16.74	7.12	.102	3.71	7.61	1.59	3.27	.372	.23	98.45
2950	57.34	.807	15.89	6.89	.116	3.67	9.05	2.39	3.53	.211	2.58	97.44
2954	55.54	.832	17.41	7.55	.111	3.62	8.88	2.40	3.25	.405	1.59	97.86
3296	58.99	.852	18.77	7.76	.096	3.53	5.13	1.39	3.31	.179	1.36	99.63
2953	57.49	.835	16.80	7.26	.117	3.61	8.69	1.79	3.23	.178	9.96	99.94
3297	63.46	.727	14.45	5.46	.095	2.89	8.43	1.76	2.54	.176	7.89	98.81
3249	61.79	1.17	20.53	12.3	.032	.94	.55	.31	2.27	.151	.00	100.74
3250	61.51	.841	21.81	7.58	.199	1.15	1.36	.83	4.63	.093	.00	99.88

Trace elements (ppm, by wt.)

	V	Cr	Ni	Cu	Zn	Rb	Sr	Y	Zr	Ba	Ce
1987	162	140	73	49	116	191	255	31	152	551	75
2930	154	136	75	54	106	192	281	31	154	607	77
2931	155	142	83	48	120	193	263	29	148	521	90
2932	163	141	77	63	129	191	255	29	145	553	65
2933	165	137	78	56	124	193	255	29	149	519	74
2934	162	140	78	61	120	198	259	28	150	545	87
2935	159	138	77	54	115	191	270	29	147	531	73
2936	166	139	76	36	121	197	251	28	143	513	75
2937	166	141	75	54	115	182	254	28	145	559	80
2943	167	244	72	26	112	185	261	28	147	581	87
2944	164	139	77	27	111	180	258	28	148	597	87
2945	157	137	77	37	108	181	284	28	154	569	83
2946	163	140	76	46	114	188	277	29	150	610	72
2947	156	142	76	52	115	181	265	26	147	587	72
2948	134	138	73	46	107	180	262	27	150	614	78
2949	133	136	69	105	112	173	250	25	150	575	67
3298	133	143	76	52	130	178	278	26	150	589	86
3299	117	132	70	54	116	162	262	26	170	524	75
2940	159	135	76	35	112	175	260	28	149	570	86
2941	142	126	65	21	83	88	435	27	175	522	71
2938a	156	135	74	29	115	186	208	32	172	575	76
2938b	149	137	73	54	118	184	209	27	164	557	93
2939	152	140	74	43	125	196	208	30	166	564	76
2942	139	126	68	49	106	159	295	28	173	523	71
2950	127	121	60	43	93	158	378	28	171	539	68
2954	125	129	67	41	102	137	287	29	151	550	76
3296	140	139	76	44	108	168	292	25	168	552	92
2953	141	123	63	48	98	172	254	27	167	563	70
3297	107	100	44	35	75	127	244	28	212	468	76
3249		14	34			120	104		234	383	
3250		10	36			193	86		161	270	

\* (Original sum of measured concentrations. In order to minimize the analytical errors the analyses are normalized so that the sum of the main elements becomes 100 %)

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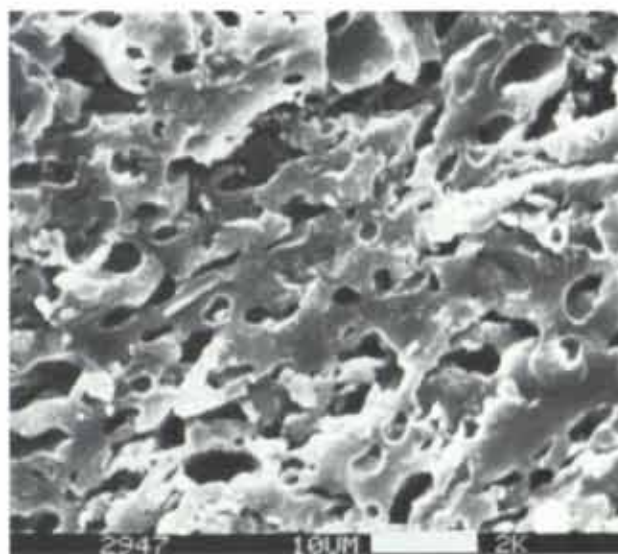


Fig. 1

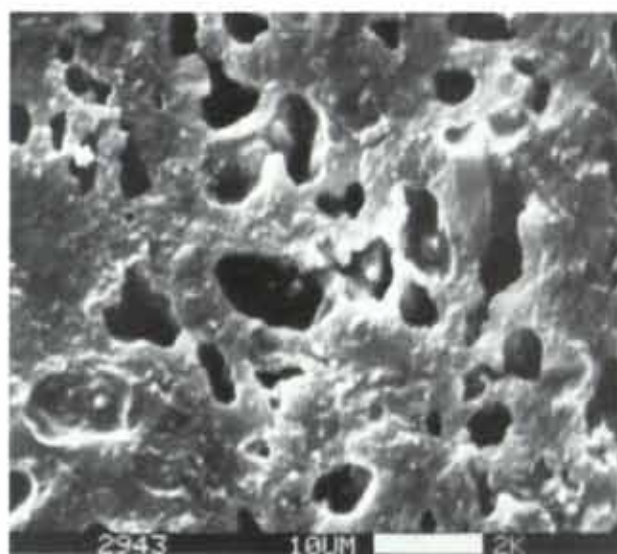


Fig. 2

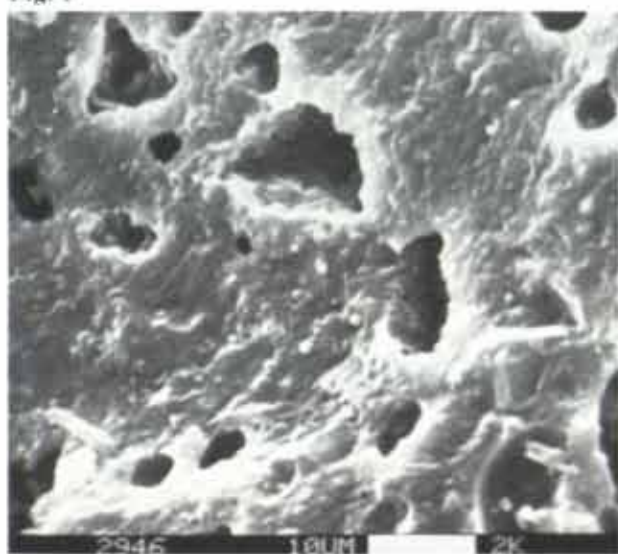


Fig. 3

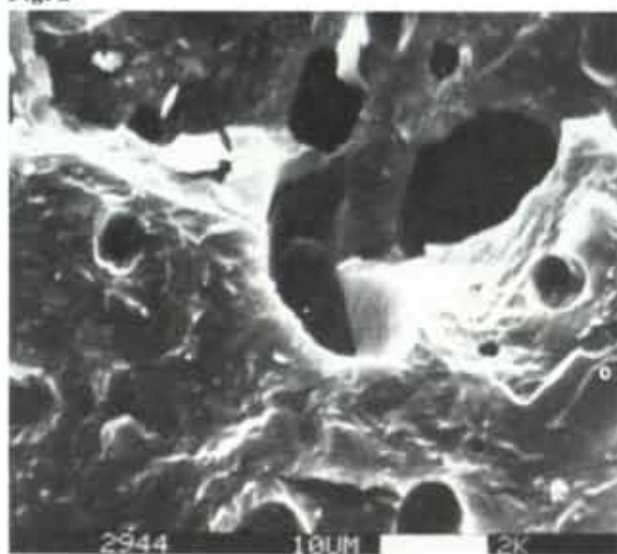


Fig. 4

**Fig. 1** Scanning electron microscopic image of a broken surface of a red bangle fragment (2947)

**Fig. 2** Scanning electron microscopic image of a broken surface of a grey bangle fragment (2943)

**Fig. 3** Scanning electron microscopic image of a broken surface of a dark grey bangle fragment (2946)

**Fig. 4** Scanning electron microscopic image of a broken surface of a grey bangle fragment (2944)



# A Model of Morphogenesis for Mohenjodaro

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## Introduction

The model proposed by Michael Jansen (see the article in this volume) wherein Mohenjodaro is envisaged as having risen initially on natural reliefs (terraces or mounds) in a more elevated position than the surrounding countryside and then as subsequently having expanded through the construction of mud-brick platforms, responds to some of the most important queries regarding Mohenjodaro as well as to a requisite of an ideological nature.

The queries are those already reported by M. Jansen in the above mentioned article:

- a deposit of pure silt at relatively high levels (traditionally interpreted as deposits brought about by flooding);
- the existence of ceramic fragments to a depth of up to 18 meters from the present surface level;
- the absence of fortifications;
- the existence of depressions;
- the prevalence of streets running north-south.

The requisite of an ideological nature is that of trying to find answers to the questions on Mohenjodaro without necessarily resorting to cataclysms and/or catastrophic events.

This type of approach could be considered rather unscientific and at any rate more of idealistic stand than one of a positivistic-experimental nature, but as we are dealing with a case like Mohenjodaro I believe that this stand is justified.

Many things, in fact, have been written on Mohenjodaro and in particular on the motives of its form and the possible causes of its demise.

Some scholars have preferred to give priority to the theory of exceptional natural causes such as catastrophic floods and/or tectonic movements that obliged the inhabitants of Mohenjodaro to undergo recurring destructive events up until the final destruction (*Raikes 1965, 1968, 1984; Dales 1983*). Others, however, have placed the accent more on human factors and economical process, ascribing greater importance to his intervention, seen as both constructive, erecting works to protect and control over natural events (*Jansen 1985*), and destructive, as he probably induced environmental deterioration through the incautious use of available resources (*Wheeler 1968; Fairervis 1961, 1984*). Others again have attempted a compromise with various, not necessarily catastrophic natural causes (*Lambrick 1967, 1973a, 1973b*).

Let us examine the form the problem took and the form it takes. Today Mohenjodaro presents the picture of a city that was abandoned at a particular point in time, from which a process of degradation and alteration began due to either natural causes (erosion etc.) or to the presence of man.

The matter at hand is to get to know the evolution and the pattern of this city (morphogenesis) — we know its final state, we do not know its initial steps, but we know certain aspects of its form in intermediary moments.

## The Theory of Models

Here is the complexity of the phenomenon to be studied and here appears, rather heavily, a situation of indeterminateness that makes modellization necessary, or rather, the necessity to derive a system to simulate the situation of departure through a certain analogy.

This process begins with the formulation of a question on the situation, we are faced with, which is transferred through the analogy onto the model which in turn is made to evolve in such a way as to provide an answer. By applying the analogy in the opposite direction, we obtain an answer to the situation observed that is then compared with the data of experience.

Penetrating further into the logic of models, these can be seen as being composed a priori, of two parts: One relative to the moment in which the parameters are assigned to the states of the process considered, the other dynamic, the description of the temporal evolution between the forms or between the states of the process (Thom 1980).

The case that we shall examine is quite particular in as much as it will deal with the construction of a model on the basis of historic, archaeological, geomorphological and geophysical data, that explains the morphogenesis of the protohistoric site and that is historically coherent with our knowledge of the Indus Civilization. The first part of the operation, the assigning of parameters, in our case, the gathering of data and, leaving aside for the moment the manner of gathering historic-archaeological data and the choice of both geomorphological and geophysical methods, this represents a fundamentally passive act.

The dynamic part of the model, however, has quite a different importance in the understanding of the phenomenon as it represents the description of the phenomenon's and/or the form's evolution through time.

This fact, in the case of local geophysical-geomorphological models that have to explain archaeological situation, is almost always described in qualitative terms and very rarely in quantitative ones. It is the researcher therefore, who intervenes with his/her qualitative judgement to describe the evolution of the phenomenon and the individual personality and psychology will weigh on the interpretation of this phenomenon.

This being so, the researcher has the added task of intellectual self surveillance, self analysis so as to be able to recognize how much one's culture, education and psychology influence the formulation of theory or, as in our case, the construction of models (Bachelard 1949).

## Mohenjodaro

The program of geophysical research at Mohenjodaro began with the aim of tracing the buried form of this protohistoric site in order to learn about its initial phases and form in relation to life on the Indus.

In the course of the years 1983 through to 1985 abundant data have been collected and some relevant results have been obtained (Cucarzi 1984, 1985; Zolese 1985).

Certainly we are not yet able to prove or disprove in a definite manner any of the hypotheses previously mentioned, but the degree of our knowledge of Mohenjodaro has certainly increased, even though a certain margin of uncertainty remains.

The ideological requisite mentioned at the beginning consists therefore, in an attempt to explain Mohenjodaro's patterned evolutionary process with a model that avoids bringing into play true catastrophic events and that sees man, rather than nature, as the protagonist, bearing in mind the normal conditions of the environment where Mohenjodaro is located: the flooding of the Indus and its meanderings in the course of centuries — without excluding that this obeys different hydrogeological parameters due to different climatic conditions (Singh 1974; Mishra 1984). With this assumption we deem it necessary to explore every possible reason in order to find explanations for this phenomenon in terms of a mild evolution. Catastrophic events remain greatly fascinating for the people, but from the scientific view point they can constitute the explanation of a phenomenon hurdling, in reality, a whole of events that lead to the same conclusion.

In doing this we are not hindering research on Mohenjodaro, we are merely proposing an interpretative model, of which the principal characteristic is flexibility (Bellone 1973) without prejudicing in any way the final nature of the reality, but leaving open a further solution that can be largely integrated into a global structure, but still leaving the possibility to interpret the same phenomenon in different ways.

## The Jansen Hypothesis

M. Jansen departs from the assertion that the Indus Civilization was constituted of a population with a riverine culture and, in the case of Mohenjodaro, of a population that knew the Indus and its behaviour. This population therefore lived with the river and not against it (Jansen 1986).

With this assumption in mind, he hypothesized that the settlement's first nucleus was on an elevated tract of clayey terrain that would have afforded defence against the seasonal flooding of the Indus. With the increasing need to occupy more space, the inhabitants of Mohenjodaro began to construct clay platforms to raise the level of the settlement area. In order to do this they extracted primary materials from adjacent zones and thereby created depressions in the terrain.

To sustain his model M. Jansen takes into account that these certain data exist:

1. The constructions at the greatest depth, surveyed in previous excavations are at 44 m a.s.l.;
2. The finds of fired bricks and ceramic fragments are at 36 m a.s.l. (from Nedeco etc.).

Jansen's thesis therefore, is that Mohenjodaro represents the moment in which the urban phase explodes in the Indus Civilization and, that in order to build Mohenjodaro they constructed gigantic clay and/or mud brick platforms to raise its base level, mainly to protect themselves from the recurrent flooding of the Indus. They extracted the primary material from adjacent zones thereby creating valleys that represented the physical limits of the city as well as forms of defence.

### New Geophysical and Stratigraphical Data

During the 1983, 1984, 1985 campaigns numerous geophysical investigations were carried out within the overall program of geophysical exploration at Mohenjodaro.

Up to the present moment, measurements have been taken on magnetic susceptibility, the intensity of the magnetic field, horizontal electric profiles as well as vertical electric soundings. Furthermore, numerous stratigraphical samplings have been made to a depth of 3 meters and three perforations up to 20 meters. Research has been concentrated fundamentally in three zones (Fig. 1):

1. HR south depression;
2. HR north depression;
3. Citadel depression between SD and VS.

Through the measurements of the magnetic field in the southern zone of HR, it has been possible to evidence the existence of a horizontal clay/fired brick interface, 800 meters long and orientated east/west 2° north (Fig. 2).

This interface was then tested with a series of stratigraphical samplings up to a depth of 3 meters that revealed, on average, a situation like that in Fig. 3.

Facing mound M36 (Fig. 3) 3 meters from the remains of a wall that runs parallel to the depression (east-west direction), a bore (BC1) was sunk 19 meters deep that revealed a lithologic log as in Fig. 4. The vertical electric sounding VES 21 reveals that towards the center of the depression, 17 meters from mound M36 the depth of the anthropic deposit reaches 10/11 meters b.g.l., confirming both the data offered by the wave analysis of magnetic anomaly (Fig. 5) and that offered by Dales' boring (Dales 1983) carried out 30 meters towards west opposite area D.

What does this interface line represent?

In our opinion, there are three possible explanations:

1. The remains of an ancient bank of the Indus or one of its canals in existence before the settlement, existing at the same time as the settlement and active or not for a certain period; subsequent to the settlement and later disactivated.
2. Part of an ancient branch of the Indus, or one of its canals modified by man with rectifying operations.
3. A work constructed entirely by man.

### HR NORTH DEPRESSION

In the north depression of HR numerous magnetic profiles in a north-south direction have been carried out as well as a long profile of 250 meters in a north-south direction crossing both the north depression, the area with structures of HR and the south depression (Figs. 3, 6).

None of these revealed the presence of anomalies similar to those encountered in HR south and in any case, the situation seems to be notably different from HR south. Anomalies in the intensity of the magnetic field evidence mild changes in the horizontal sequence of the layers.

A boring operation (BC2) was also carried out on a mud-brick wall, visible on the surface (photo 1).

After a layer of 5.30 m. of mud-brick and clay, the equipment we had at our disposal was not able to perforate a level of fired bricks.

### THE DEPRESSION BETWEEN THE CITADEL AND VS

In the depression existing between the Citadel and VS two long magnetic profiles (250 meters) were carried out with an approximately east-west (Fig. 7) orientation.

Both reveal the existence of two clearly evident anomalies, one on the east margin and the other to the west of the profiles, while the course between these two points is exceptionally regular (Fig. 8). This is to be interpreted that in the tract of depression crossed by the profiles there are no buried fired brick structures as fired brick emerges quite quickly.

The wave analysis for anomalies does not reveal many similarities with that encountered in HR south except for a short tract near VS, even if the increase in field values occurs with a lower gradient.

VES 20, carried out at 80 meters west of the VS structures which (Fig. 9) confirms the absence of buried levels of structures in fired brick (Cucarzi, in press).

### INTERPRETATION OF DATA

Let us recapitulate quickly on the data we have and that will be born in mind in constructing an interpretative model.

1. All the data from previous excavations that substantially indicate structures ascertained up to 44 m. a.s.l..
2. Borings carried out by Nedeco (1966) in the Old Site that reveal the presence of remains in fired brick and ceramic up to -18 b.g.l. (31 m. a.s.l.).
3. Borings carried out by WAPDA on the borders of the site that indicatively confirm the Nedeco data.
4. Borings carried out by Dales in 1965 in HR south (bricks and pottery up to 12 b.g.l.).
5. Geophysical and stratigraphical data of the Italo-German Mission.

Let us begin to take into consideration the depression between the Citadel and the Lower Town and in particular the area included in the band between the magnetic profiles *MAG 54* and *MAG 55 Y* between SD and VS.

As already mentioned, the magnetic measurements (*MAG 45, 55*) and the geoelectric ones of *VES 20* have shown that in the band under examination, buried structures in fired brick are not present, while approaching in an easterly direction, the structures visible on the surface (*VS*), structures emerge rapidly. If we construct an east-west section with the data from the Nedeco borings in the Old Site: *E3, E2, E1, W1, W2* (with a direction approximately parallel to the magnetic profiles), we are able to note that the lowest level of the probable construction in fired brick exists at -15 b.g.l., resting on a 2-3 meter thick layer of clay which, in turn, goes down to the base layer of sand (*Fig. 10*).

Following the section in a westerly direction, the level of bricks, or brick/sand and clay (the anthropic layer) rises, diminishing in thickness, before coming to the point of test *W2* where it exists only between -2 to -6 meters b.g.l.

If we continue to the west, the geophysical data reveal that this level is rapidly reduced to zero (*VES 20*). *Fig. 10* bears the representation of this.

We are therefore able to think that the deepest structures in this area are at -15 b.g.l. with a depression zone of up to -18 b.g.l. on the sides of the tract of clay, and following the section, a model could be conceived that evolves according to expansion and raising by platforms and constructions in clay. The necessity for this is induced from subsequent overflowings of the river, witnessed by the presence of silt in the zone of contact with the artificial platforms in clay.

Let us move on now in HR onto the north-south profile that crosses HR/E and that comprehends both the north and the south depression (*Fig. 11*). The results of the boring *BC 2* can be explained as if at a level that finishes at -5.30 another has imposed itself, represented by the mudbrick platform that is also visible on the surface. This phase could be evidence of the expansion of the site by platforms towards the south.

Let us once again ask ourselves the question: what does the clay-filling interface line of the depression in HR south represent?

There are two crucial points to be borne in mind:

1. *BC 1* revealed up to -17 b.g.l. a sequence of clay and sand without the presence of pottery or brick fragments.
2. Both the conclusions drawn from the geophysical examinations and the results obtained from the borings executed by Dales in 1965, reveal layers of anthropic deposits up to -12 b.g.l.. The situation can therefore be represented as in *Fig. 11*.

It is possible therefore, that the interface line in the south depression of HR represents a situation that shows as follows: initially, there existed a tract of river (and/or canal) that, at a certain point in time, became no longer active and that was used by Mohenjodaro's inhabitants as a boundary area during the city's phases of expansion. When, through the continuous floodings of the Indus, this boundary no longer represented a secure embankment, they built a new stage of clay and mudbrick platforms on top of it in such a way that the site could expand without being submerged in these waters.

It is worthwhile bearing in mind that another possible cause of destruction and therefore of the necessity for isolation, could have been the rising of salt by capillarity, as is proved by its presence in buried fired bricks in ancient layers from the analysis by Dr. Udo Ludwig (*Ludwig 1984*).

As things stand we do not know if the tract of river was active or not during the whole inhabited phase of Mohenjodaro, or whether it became inactive before the rise of the city. In any case, there is considerable evidence indicating that this line represents a southern boundary for this protohistoric site.

The evidence may be summarized thus:

- The fact that neither the southern continuation of HR nor that of the First Street, nor that isolated by Dales in 1965, have been found yet;
- that all the wall remains one sees in HR south near the contact area of the un-excavated areas and the depression have an east-west course;
- that beyond the depression HR south incorporated buildings in an urbanistic order like the rest of the settlement are not noted.

### Interpretative Model

On the basis of what has been set out up to now, we have constructed a model on the morphogenesis of Mohenjodaro that envisages that at a particular time, that for us is  $t=0$  (but not necessarily the time of the earliest settlement which has not yet been verified) of its formation, a settlement -15 b.g.l. in the area to the east of SD.

For a period that is not yet able to be established, Mohenjodaro is cyclically invaded by the seasonal floods of the Indus up to the moment when the new constructing techniques appear, represented by the large clay or mud-brick platforms at Mundigak, Mehrgarh, Harappa, Kalibangan and Lothal (Casal 1961; Jarrige 1984; Vats 1940; Wheeler 1984; Thapar 1973; Rao 1979).

At this point, the site's configuration evolves with a horizontal expansion through the use of clay and mud-brick platforms, and constructions with material from the pottery industry and/or vitrified nodules.

The growth of the lower city continues; to the west of the boundaries approximately represented by the line L2 and south of those of line L1, the boundary of the bank of a supposed ancient river bed.

Outside of this area and the citadel, that presumably underwent a similar evolutionary process, it is conceivable that the area continued to be cyclically invaded by the seasonal floodings of the Indus.

## Conclusion

The model here presented is justified *a priori* because it is founded on the analogy between a series of data relative to it and data of the real situation. An *a posteriori* justification is given, however, by the comparison with experience, or rather the comparison of model's response with experimental data. The next geophysical and geoarchaeological campaigns to be conducted at Mohenjodaro will be characterized by this: *the experimental validation of the model*.

Even in the case of this model being verified, numerous queries would still be left to be explained, but these could, however, find their answers within the whole of the envisaged investigation.

One of the key points certainly is represented by the importance of an accumulation of 15 meters of anthropic deposit. This datum has been held as true, based on the results of the tests carried out by Nedeco in 1966, although they were not checked with subsequent drillings, but this is planned for the next program. If the layer thickness value is confirmed, an explanation will have to be found as the calculations made to date on the extent of the aggradation of the Indus with the present hydrogeological parameters does not allow a greater increase than two meters every thousand years.

The justifications for an almost double value could be found in terms of a set of different hydrogeological parameters due to a different climate and/or a greater number of tributaries flowing into the Indus (like the Bolan) and therefore a higher degree of aggradation.

Should size checks on the deposit lower the value, the model would be still valid, and with even more reason. Another key point in understanding the morphogenesis of Mohenjodaro and its function as regards life on the Indus is constituted by the validity of the hypothesis on the nature of the clay-fired brick interface line in the south depression of HR, together with the stratigraphic sequences in the two depressions.

It is therefore conceivable that the geophysical, sedimentological, geohydrological, geobotanical and palaeo-ecologic research envisaged by the program linked with archaeological surface investigations and urbanistic studies will be able to furnish a new set of data that can be used for the construction of a structurally stable model of the morphogenesis of Mohenjodaro.

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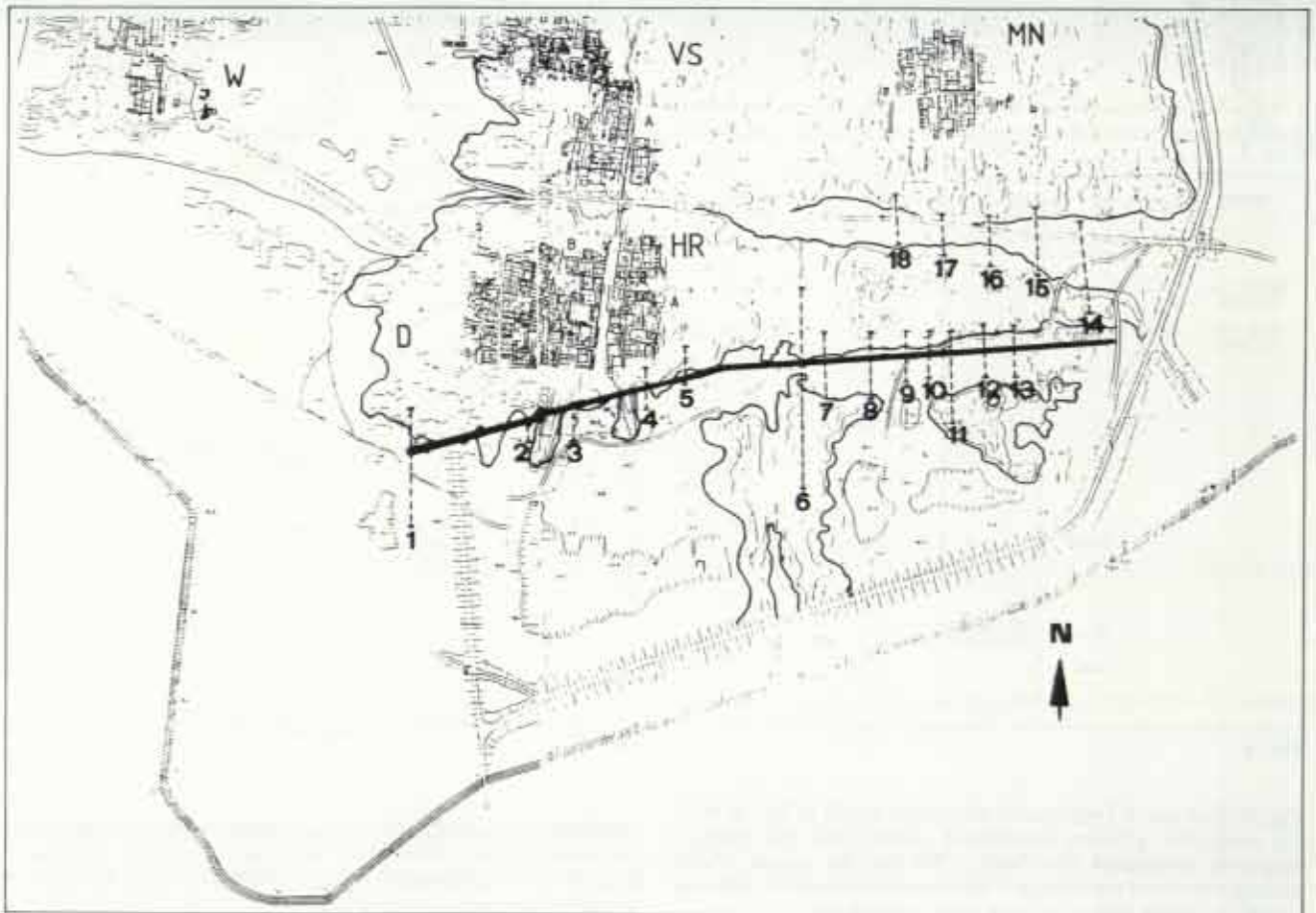


Fig. 1

**Fig. 1** General map of Mohenjodaro showing the four areas (1, 2, 3, 4) investigated with geophysical methods (dashed lines); New Site and Old Site are the points where Nedeco drillings were carried out in 1966.

**Fig. 2** Full line shows the position of the interface clay/bricks interpreted as clay or mud/brick platform.

Fig. 2



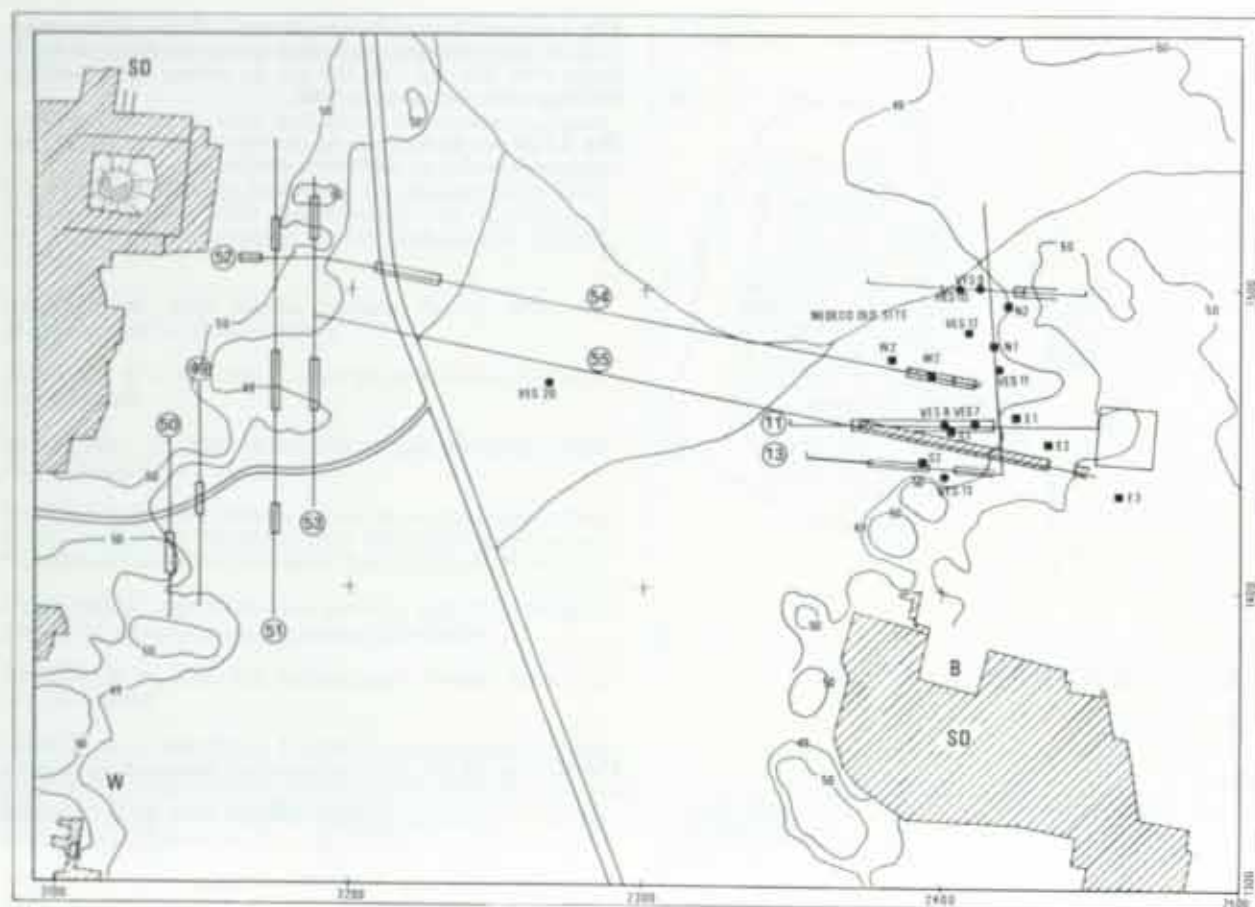


Fig. 3

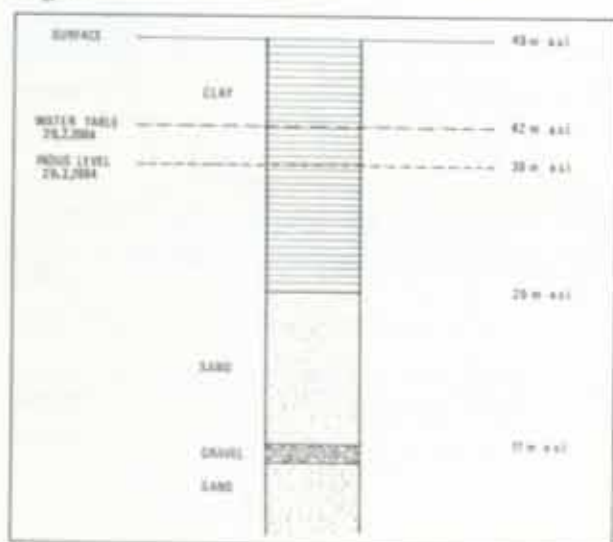


Fig. 4

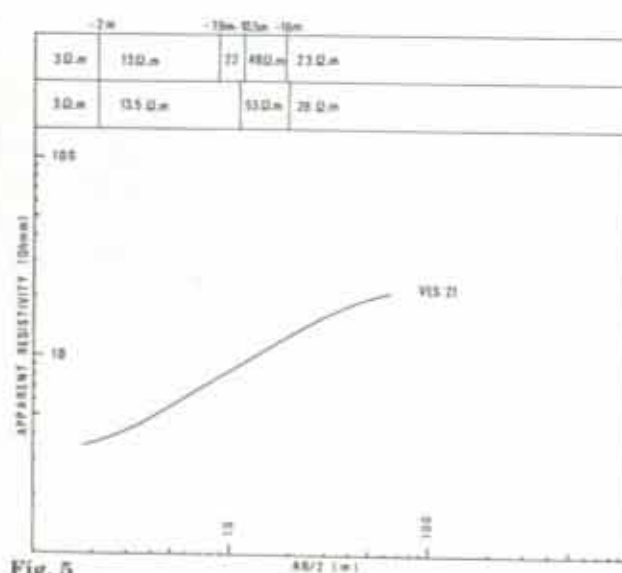


Fig. 5

Fig. 3 Area no. 4: Depression north and south of HR/E with the magnetic profiles (numbered lines) and the relative magnetic anomalies (hatched). VES are the points where vertical electrical soundings (VES) were made and BC (Boring Core) indicates where borings were carried out.

Fig. 4 Stratigraphic log of boring core BC1 drilled in HR south.

**Fig. 5** Vertical electrical sounding VES 21 with the pair of possible interpretations (on top).

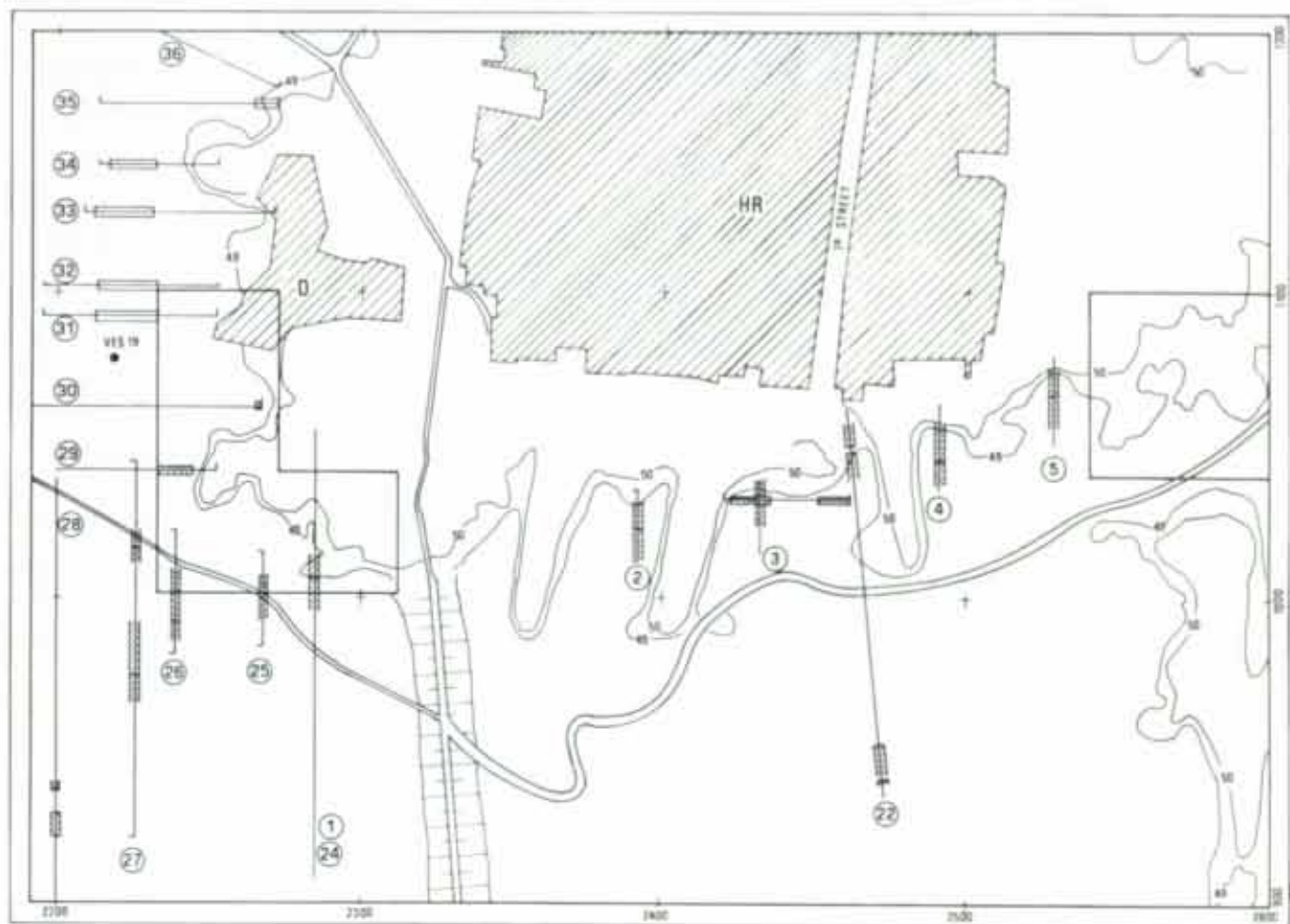


Fig. 6

Fig. 6 Area no. 3: Depression south of HR and D areas with the magnetic profiles (numbered lines) and relative magnetic anomalies (hatched). VES indicate the points where vertical electrical soundings were carried out.

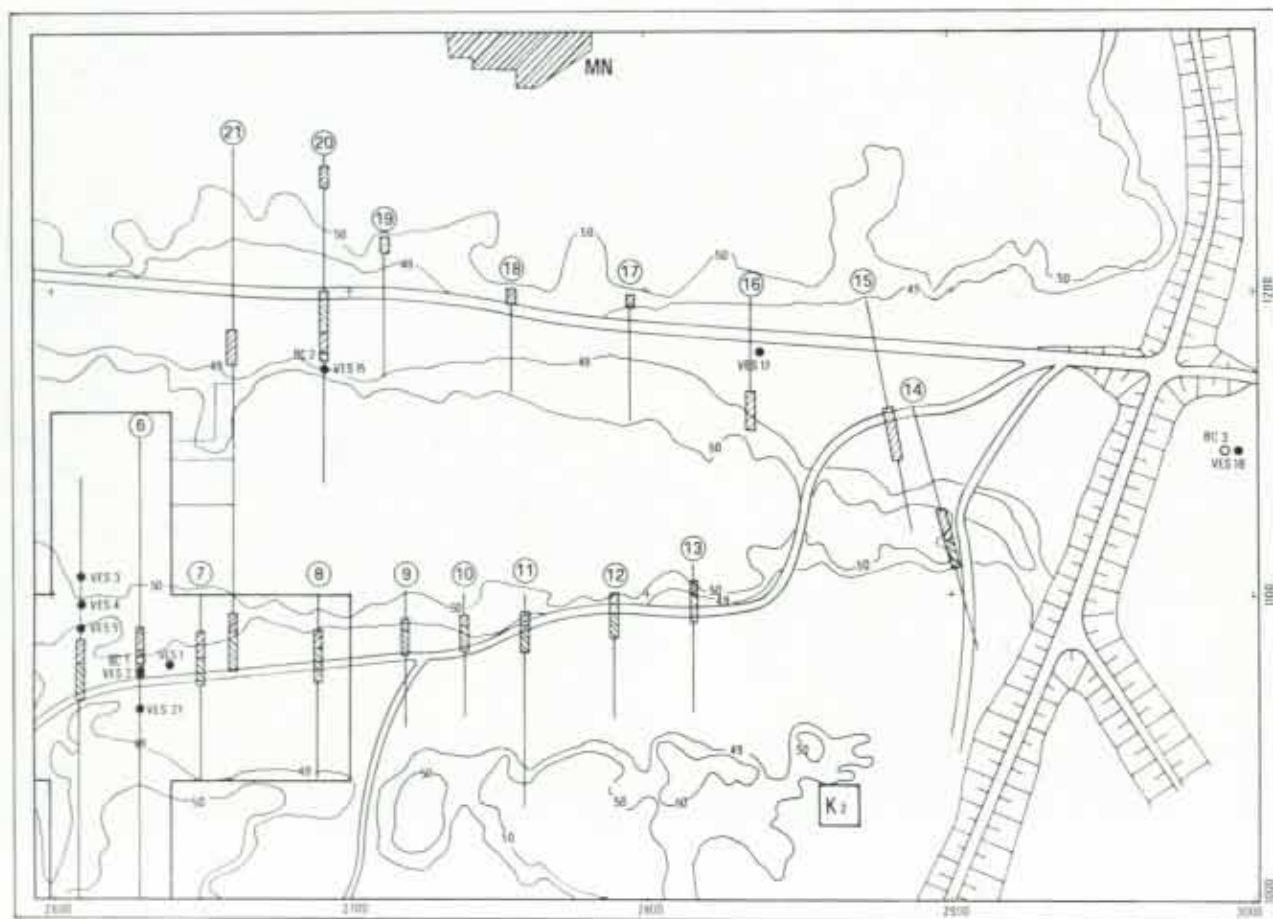


Fig. 7

Fig. 7 Area no. 2: Depression between the Citadel and VS area with magnetic profiles and the relative magnetic anomalies. VES are the points where vertical electrical soundings were made and E1, E2, E3, E4, E5, N1, N2, S1, S2, W1, W2 are the points where the Nedeco company carried out drills in the so-called Old Site.

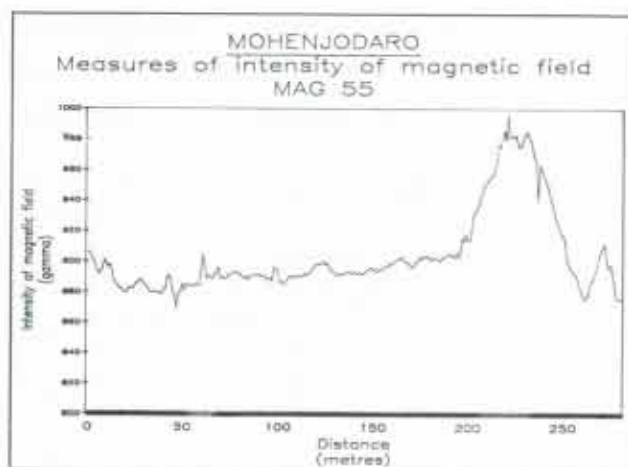


Fig. 8

Fig. 8 Diagram of magnetic profiles *MAG 55* made in area no. 3.

Fig. 9 Vertical electrical sounding *VES 20* carried out in area no. 3 with the stratigraphic interpretation (on top).

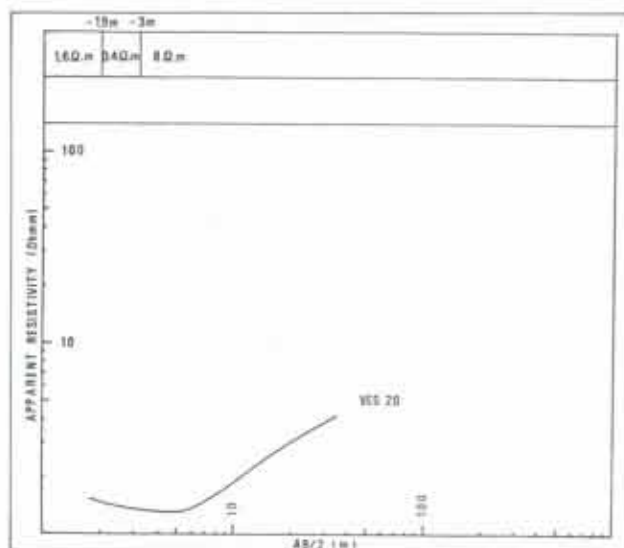
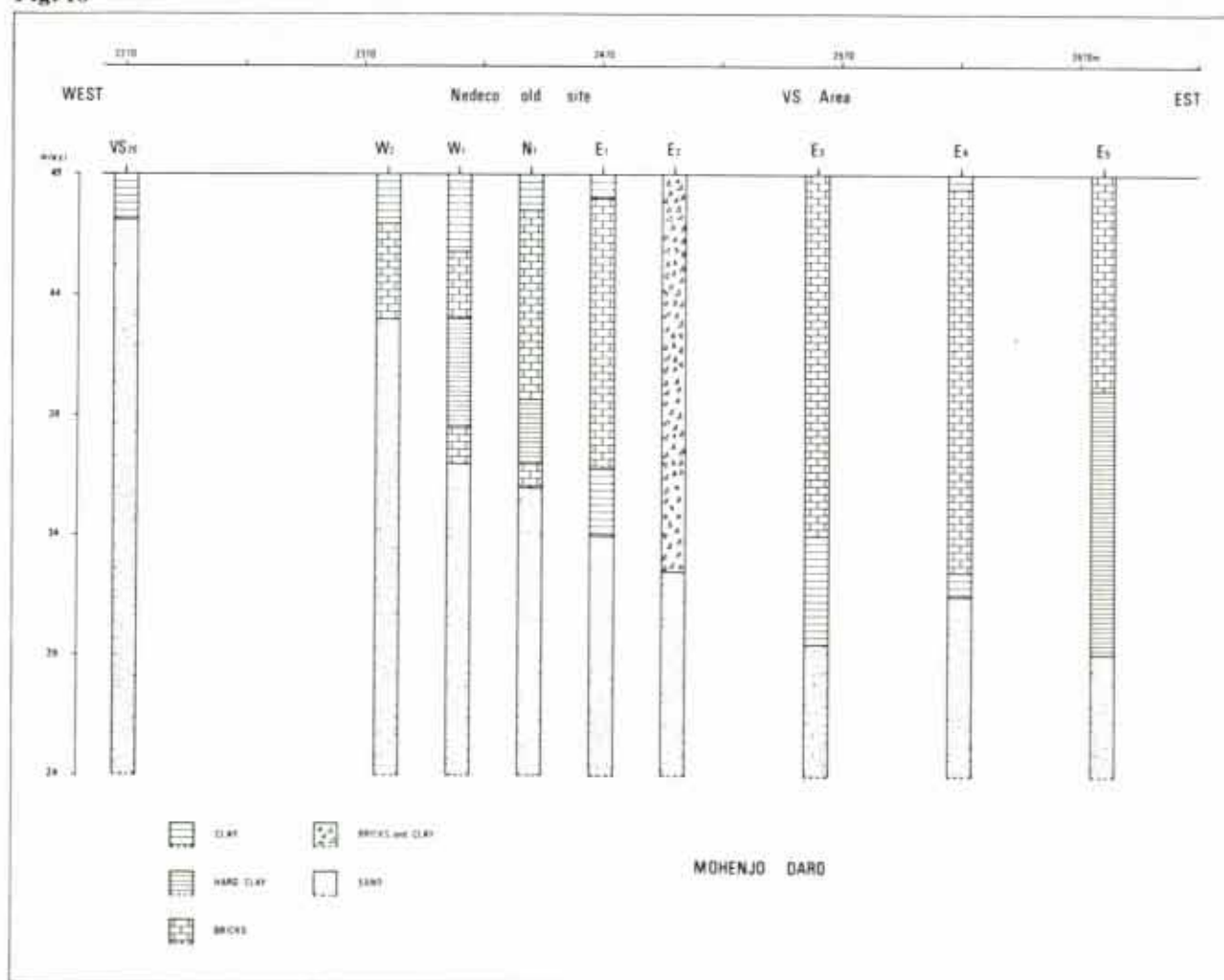


Fig. 9

Fig. 10 Section W-E made with the results of the Nedeco data in the Old Site and with *VES 20*.



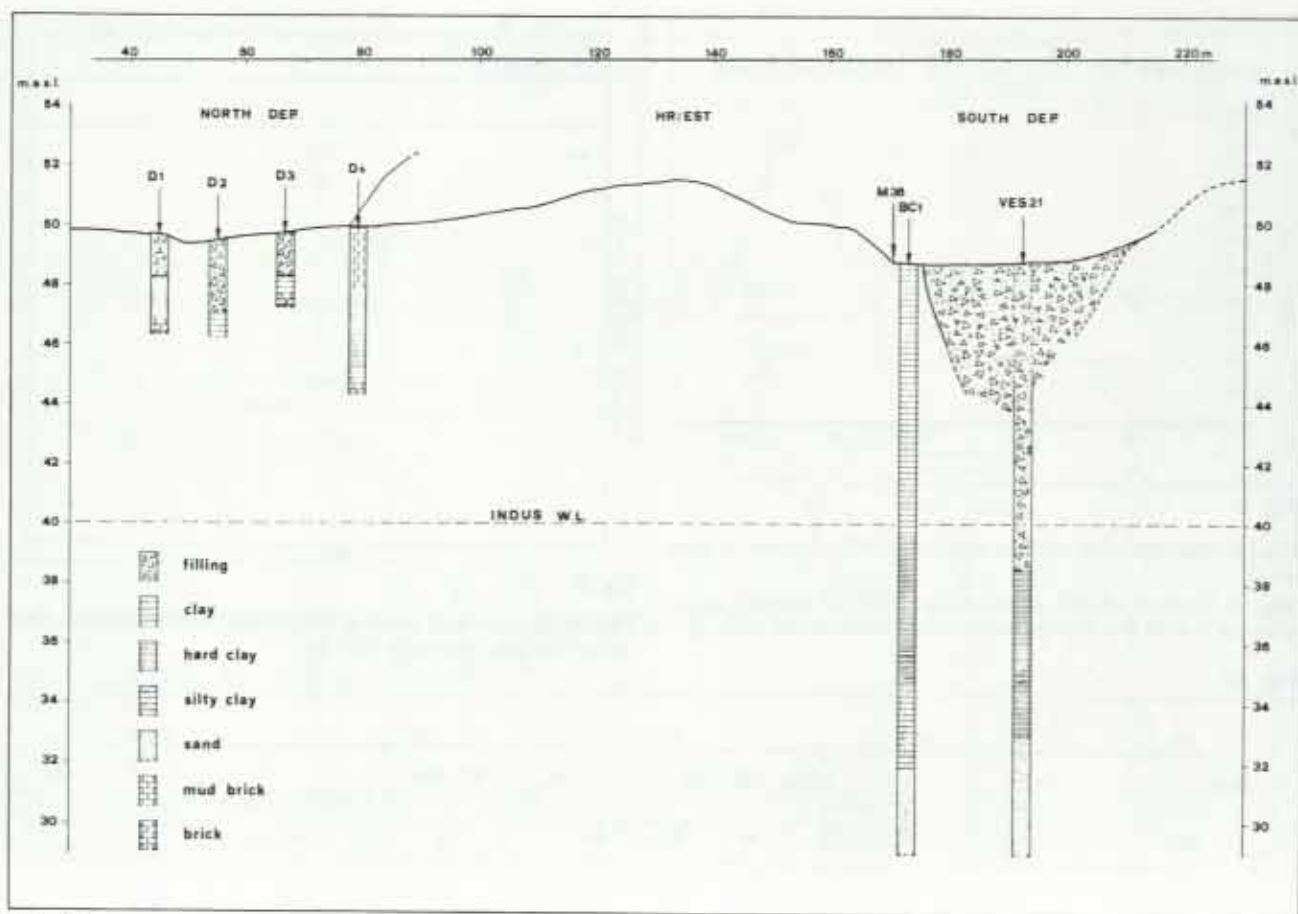


Fig. 11

Fig. 11 Cross-section N/S through HR/E along the magnetic profile *MAG 21*. Indus water level is that measured on March 1984.

# Preliminary Research on the Degradative Evolution of the Deposits and the Dislocation of Archaeological Indicators of Craft Activities on the Surface of Moenjodaro

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The geo-archaeological research carried out in February 1984 in the site labelled Moneer South-East Area (hereafter MNSE Area) of Moenjodaro is part of the broader Surface Evaluation Programme developed since 1982 by the Joint German-Italian Project.<sup>1</sup> In particular, our contribution may be conceived as an integrative research approach within the parameters of the surface survey of the craft activity areas detected across the compound (Bondioli et al. 1984; Pracchia et al. s.d.), with the specific purpose of understanding *"the effects of erosion on the archaeological deposit, resulting in the spreading of artifacts and the related geomorphic process"* (Bondioli et al. 1984: 11). In this perspective, since 1982, the MNSE Area has already been the subject of an extremely detailed surface survey by M. Vidale, aimed at singling out the distribution of the Archaeological Indicators of Craft Activities (hereafter AICA) (Tosi 1984: 24-25) across the sampled area. Consequently, after a general field analysis of the urban compound of Moenjodaro, we concentrated our efforts on the already selected MNSE Area, allowing an experimental testing stage on the relationship existing between the massive and uneven distribution of AICA and the surface geomorphological setting.

At this preliminary stage we drafted a geo-archaeological map of the area, a first interpretative analysis of the main processes active in the area (salinization and meteoric erosion) before finally proposing an interpretative model on the question of the geo-archaeological system with destructive valence characteristic of Moenjodaro.

C.B. G.L.

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## Main geo-morphological features of MNSE Area

The examined area of the mound (40x65 m.) (Fig. 1) in MNSE Area corresponds to a part of the right-hand hydrographic side of the small lateral valleys running down from the Moneer mounds and opening, following an almost normal course, into the wide depression separating the HR insula from the main compound of the lower town. Such a small lateral valley is produced by the partial filling by alluviation of an ancient

structural depression belonging to the town's urban network. Conforming to the altimetric setting normally associated with the residual mounds of the compound, the western side of the small valley departs from a higher elevation and exposes a broader surface than the eastern side. The rare but intense local precipitations thus have the chance to operate onto a wider hydrographic basin; their effect is further enhanced by a substantial component of sub-surface run-off via piping along the slope, due to the water funneling active on the peri-summital plateaus surrounding the central elevations of the Moneer mound, whose structures were extensively undermined in early excavations. These factors cause the substantial degree of dissection characterizing MNSE Area, which is furrowed by a network of erosion gullies ranging in morphology from linear to branched, connecting the plateaus with the floors of the small valleys (septentrional zone, with an average gradient of 10%) or departing from the two secondary plateaus, interrupting the slope with a relative difference in height of some meters (middle-southern zone of the slopes with an average gradient of 15-20%).

The basal basin of the valley thus collects the confluences of the smaller but active tributary basins, and is connected, in turn, with the above-mentioned wide depression through a main channel with ephemeral drainage, characterized by an almost non-existent longitudinal slope (0.5-1.0%). The prevailing geomorphological ranges coincide with a "non-erosion" zone on the plateaus, with an "active erosion" zone along the slopes and a "fast alluviation" zone in the basal basins (Figs. 2 + 4).

#### Criteria of geo-archaeological surface mapping in MNSE Area

The surface survey of the main geo-archaeological residual units in this zone of Moenjodaro (Fig. 3) started from a descriptive decodification according to morphological, textural and compositional criteria, in turn resulting from the recognition of the various degrees of exposition, dissection or weathering of the different local archaeological deposits.

Given such a confusion of outcropping features, in our cartographic schematization we have been compelled to juxtapose residual structural units (i.e. walls and platforms in fired and/or mud bricks), usually occurring on the headwaters of the gullies, and whatever

units resulting from the former ones but which are now partially obliterated by the intense saline weathering (e.g. zone of the plateaus). In the mid-slope sections the deep lateral cuttings of the gullies allowed us to observe, in spite of the partial covering of saline encrustations, the textural and compositional morphology of the deposits formed by intentional fillings or dumped debris. Finally, on the basis of the compositional elements, the matrix inclusions, basic hue of the sediment and the distribution of the main textural classes (evaluated by means of the limited drawings of the sedimentological sampling) we were able to define the relative surface limits among the units more intensely degraded and/or with multiple composition, mainly occurring across the summital plateaus and mid-slopes of the site (Fig. 4).

#### Geo-archaeological units identified in MNSE Area

##### PRIMARY ANTHROPIC UNITS<sup>2</sup>

##### — STRUCTURAL ELEMENTS:

a. Walls or platforms of fired brick (A) including mortar formed by silt with clay and sand; b. walls or platforms of mud brick (D).

##### — DEPOSITS FUNCTIONALLY CONNECTED WITH STRUCTURES (FILLINGS) (G, H, I):

We have been able to define different types of fillings, resulting from re-elaboration with eventual re-mixing of different materials: potsherd-fillings (G), mixed fillings (H), mixed fillings with charcoal (I). These types may anyhow be considered as a single class, given their common function. Their mixed compositional features, moreover, induces an analogous behaviour in relationship to both saline alteration and erosion.

##### — KILN (F):

Presumably installed over an area already in a state of advanced degradation of the structural anthropic sub-strata.

##### — DUMPS (J):

Resulting from domestic and/or industrial activities, performed in presumably abandoned and/or peripheral areas.

##### — OVERFIRED TERRACOTTA NODULES (O):

The scarcity of such indicators on the site prevented us from ascertaining whether they resulted from the decay of a preparatory filling for a structural floor (a widespread technique in the later phases of Moenjodaro) or from the refuse heap of a kiln.

We presume that such a system includes a further type of formation, namely, materials deposited or abandoned on top of floorings, a situation not uncommonly reported by the early excavators. Given the particular constraints of our survey of the degraded surface formations, we have not been able to single out those types of deposits whose presence is expected, given their certain association with AICA distributions.

Collapse formations do not range among the geo-archaeological units considered, because, although rather frequently observed in other contexts at Moenjodaro, they have not been identified in MNSE Area (they would presumably be encountered in sub-surface contexts). On the other hand, in accordance with their genetic definition and their composition, they would represent either a sub-aggregate of fired brick or mud brick walls, or an aggregate of these latter elements intermixed with materials sustained by floorings and/or contained by walls, therefore corresponding to deposits of different composition depending on the situation.

#### DEGRADATED ANTHROPIC UNITS

##### — RESIDUAL DEPOSITS:

a. Deposits containing various elements produced from decayed fired-brick structures (*B*): these are formed of fragmentary bricks, fragments of bricks of various sizes and, eventually, of flakes and granules of the most effectively disintegrated fired materials. Usually they may be found downstream and/or at the sides of exposed wall structures, or they mark sub-surface structural alignments.

b. Deposits affected by the maximum degree of saline weathering (*C*): they are formed by the minute granular-products resulting from the disintegrative evolution of fired-brick structures. They represent the type of residual unit prevailing on the surface, particularly common on the summital and mid-slope plateaus of the site.

c. Deposits representing the final output of saline weathering operating on mud-brick structures (walls and platforms) (*E*): they display extensive formations with a mainly silty-claylike texture, and occur across the peri-summital plateau and on the septentrional strip of the slopes. The weathered intermediate products, small flakes and flattened mud crumbs, are exposed only along the sides of the gullies; they have also been encountered in the profiles revealed during the sedimentological sampling (horizon "B" of the standard saline profile).

d. Granular products with mainly sandy-silty texture, enclosing intermixed cores of minute particles of fired brick and/or crumbling sherds; the matrix contains various scatterings of minute charcoal debris. Their origin may be traced in limited processes of re-sedimentation of units of type *C*, *E*, *I* (resulting from eolic actions, trampling and localized re-deposition by

surface washout). Such units have been determined only in the mid-slope zones, in association with a small intermediate plateau.

#### SEDIMENTARY UNITS FROM HYDRAULIC- GRAVITATIONAL RE-DEPOSITION

##### — FILLINGS OF GULLIES AND CHANNELS (*N*):

They are discontinuous, lenticular shaped elements, generally stratified (strata of type "cut and fill" and "planar-through cross stratification"), with prevailing granular and coarse-sandy textures, having greater values of hydraulic sorting downcurrent.

##### BRANCHES OF GRANULAR, WASHED-OUT MATERIALS, DEPOSITED INTO THE TERMINAL BASAL BASINS OF THE SLOPE (*L*):

Repetitious sub-tabular sequences of sands, granules and silts, with low grade of assortment, output of the sheetflows active in the downstream sectors of the slopes.

##### — MUD AND DEBRIS FLOWS (*M*):

Spatially limited fans with lobe-shaped borders, with heterogeneous matrix. They are dislocated by water saturation, chaotically re-mixing materials from anthropic formations, both primary and degraded, together with various concentrations of overfired clay residues and overfired terracotta nodules.

#### KEY TO THE GEO-ARCHAEOLOGICAL MAP UNITS

A-Fired brick walls: wall structures of floorings in fired brick, exposed and/or partially protruding.

B-Collapsed and fragmented fired bricks with their disintegration products.

C-Prevalent sandy-silt deposits produced by the intense alteration and disintegration of fired bricks.

D-Mud-brick walls and platforms.

E-Prevalent silty-clay deposits, produced by intense alteration of mud bricks.

F-Kiln area with charred residues.

G-Potsherd-fillings: fillings with prevalent potsherd inclusions in sandy-silty matrix.

H-Mixed fillings: fillings with non-selected artefactual inclusions with prevalent matrix.

I-Mixed fillings with charcoal: fillings with non-selected artefactual inclusions in matrix containing charcoal particles.

J-Layered waste dumpings: repetitious, lenticular-shaped sequences of charred deposits and layers with artefactual inclusions, partially burnt bone fragments, and spread charcoal bits.

K-Sandy-silt deposits produced by re-mixing materials of the types C, E, I.

L-Stratified deposits with medium-sized sand particles forming the pediments.

M-Mud and debris flow.

N-Hydraulic network with inner deposits.

O-Overfired terracotta nodules.

## Salinization

Salinization represents the main process of surface weathering of the materials outcropping on the site, in respect of both the structures and the inclusions contained in the residual deposits. Such a process apparently depends upon the relative level of the phreatic groundwater limits (whose depth ranges 1.5-3.5 m. from the average p.c.: 40 m. a.s.l.), fed from the subalveal waters of the Indus River east and the Dadu Canal to the west. The arid climate characterizing the area (with variations of temperature ranging from 45° C in June to 7° C in January, besides the frequent, strong local winds) encourages, through the potentially high rates of evaporation, the capillary rise of saline solutions (salt contained in the groundwater) up to 9 m. above the base of the capillary fringe. Surface evaporation causes the fast crystallization of the salts present in solution ( $\text{Na}_2\text{SO}_4$  and  $\text{K}_2\text{SO}_4$ ,  $\text{H}_2\text{SO}_4$  and  $\text{KCl}$ ,  $\text{CaCO}_3$ ,  $\text{MgCO}_3$ ,  $\text{Ca}(\text{HCO}_3)_2$  and  $\text{Mg}(\text{HCO}_3)_2$ ), in turn producing substantial stresses within the pores and micro-fissures of the vulnerable materials which can lead to progressive granular disintegration. The micro-morphology of the salinized deposits of Moenjodaro conforms to the local topographical variability, showing whitish, powder-like encrustations in the lowland areas (damp salt crust) and along the slopes a dry, crust-like efflorescence (as observed in MNSE Area), to finally disappear in the highest parts beyond the range of the ascending capillarity (capillarity fringe limit).

Our limited sample drawings, together with observations of the sediments exposed along the sides of the gullies, allowed us to de-codify a type-profile of saline weathering developing on the sub-strata of the site (Fig. 5). On the surface there is a strong saline encrustation (0) ranging in thickness from a few mm. to some cm., usually cementing an aggregate of granules of fired materials, chips of overfired clay, some rarer lithoid elements, etc.. We then encounter a powdery layer (A) with an average thickness of 5-7 cm., whose very homogeneous granulometric composition ranges from a sandy silt to a silty sand with a limited presence of thinly brecciated fired particles. The soft consistency of this horizon is due to the sudden and complete evaporation of hygroscopic solutions, leaving series of voids in the structure of the sediment, combined with a organization of the granules into a characteristic soft fabric. The following horizon (B) ranging, as a rule, between 7 and 25 cm. depth, appears as a moderately silty sand, joined to a more discrete fraction of small fired-brick breccia in a phase of disaggregation. Along fresh cuttings we would observe that such residual small particles become capturing media for saline solutions, and appear, after a few hours, entirely covered by clustering of gypsum needles, in turn

producing smaller crystallization in the sediment mass, following diverse vertical courses. We observe furthermore a transitional horizon (B/C) marked with a spread of ghost brick-clasts intermingled with an abundant microbreccias and granules fraction coming from the fracturing, scaling and disaggregating of loose structural pieces (baked bricks and lumps of mud bricks: 25-40 cm). Lastly, at a depth of about 40 cm., we find the sub-stratum (C), unaltered or just slightly altered, moderately moist, and characterized, once exposed and rapidly dried, by a coating of minute crystallization flakes, which in a few hours totally cover the surface of the layer. Here is preserved either the sedimentary structure of the primary deposit (in the case of incoherent formations) or the structural network of the wall or platform (both in fired and mud brick), without any evidence of saline alteration of the included elements, whatever their composition or micro-porosity features.

## Erosion

The surface encrustation produced by the salinization dynamics turns out to protect the site considerably from eolic erosion, although we were able to identify some limited zones in which this latter agent may operate (human and animal pathways and slope sections where differential thermal dilation destroys the surface crust, with the consequent exposure of the underlying incoherent horizons). In the general model of disintegration reconstructed at Moenjodaro we therefore did not take into account such a class of erosive-depositional processes; we also ignored fluvial erosion, as non-effective in the present state of the hilly compounds and definitely absent in MNSE Area.

The main erosive process operating throughout the site is hydraulic corrosion from meteoric precipitations, as evidenced by the system of rills and gullies which are almost ubiquitous across the slopes of the compound, developing, at the base of the mounds, a network of secondary furrows feeding the primary channels, in turn emptying their bed load into the wider depressions (lanes) cutting the mounded region. Given the very ineffective vegetation existing on the site, and equivalent average yearly rainfall conditions less than 100 mm. and mainly concentrated in the late summer quarter erosion, at first general and later channeled, depends on the original gradient

of the slopes (10-15%) and, as a consequence, upon the relative susceptibility to transport of the materials powdered in the saline profile once the surface crust has been re-solubilized by the first, intense precipitations. On the other hand, the original geo-morphological setting of the slopes is affected by the diversification of the emerging structures, whose variability in terms of orientation and inner composition leads to the creation of pre-ordered catching networks. The differentiation of the emersion altitude of the residual structural aggregates causes, furthermore, the alternation of more limited plateau-like morphologies in correspondence with the mid-slope sectors. The gullies' courses, although confined within the constraints of the geometric network of the site, incline to recover their natural equilibrium profile, therefore resulting zones of accelerated erosion, more and more intense according to the extent of the anomaly produced by artefactual features. Finally, it is remarkable that the removal of the incoherent salinized formations (mainly occurring along the flanks and the headwaters of the gullies) during the most intense rains creates localized expositions of the underlying more thickened deposits, which, barely coherent and saturated on the surface due to a limited seepage capacity, slip in mass along the gradient and into the furrows, generating lobes of mud and debris flows. Such deposits will be subsequently in part dismantled by the surrounding channeled hydraulic activity, or, if activated along the distal flanks of the terminal slopes, they will reach the axis of the valley, where they will be gradually re-assorted by the hydraulic transport active in the channels.

Erosive processes differentially denude the saline horizons we previously defined (*A, B, C*) according to the site's micro-morphology, down to expose in some zones (e.g. the gullies) the very unaltered substratum; these dynamics, in relationship with the degree of erosion, allow the re-starting of a differentiated salinization process, a process, therefore, that may be deemed at least partially cyclic (*Fig. 7*).

### Interpretative Models

The schematic model in *Fig. 8* presents the progressive stages of erosive degradation developing from a standard saline profile (i.e. defined by the extreme grade of evolution *A, B, C*), the relative residual

deposits (*B, C*) and the relative removal deposits, re-distributed with a selective assortment (hy.A), selective-channeled assortment (hy.B) or non-assorted (hy.g.A+B). The model moreover expresses the possible re-starting of the saline weathering both from the different residual deposits (*B* evolving to *A1*, *C* evolving to *B1* and therefore to *A2*) and from the neo-formed sedimentary deposits (hy.A, hy.B, hy.g.A+B), directly forming a new sub-stratum (*C1*) potentially object of the same saline evolution.

In the building of the described model we necessarily adopted some interpretative-processual simplifications. The three horizons produced by the saline process have been considered as discrete elements while such a saline profile has a continuous nature. As a matter of fact, horizon *A* contains, although in minimal percentage, some granulometric classes not completely removable by sheet erosion, as horizon *B* may present some classes with critical diameter not removable by gully erosion competence. Similarly, the complex of erosive behaviour has been sub-divided into the inner segments we considered more relevant from the processual viewpoint: in a sequential relationship of linked increment (sheet-gully) or, for what regards mud and debris flow (in our model operative only from the extrapolated horizons *A* and *B*) without considering that such terms may also maintain an interactive link with the above mentioned hydraulic processes.

The scheme in *Fig. 9* shows how the two models in *Figs. 8* and *10* are not limited to a graphic device to express the interactive processes among salinization, erosion and deposition. As a matter of fact, reading the various columns ideally superimposed one may observe the processual-diachronical evolution of the system, while, reading the columns' sequence from left to right it is possible to follow in a spatial perspective the main geo-morphological sectors of the site: 1st column = plateaus; 2nd column in point *B* = slopes; 3rd column in point *C* = gullies; while the inferior sequence (hy.A, etc.) indicates the context of the basal basins.

In the model presented in *Fig. 10* we examine the behaviour of the artefacts not attackable from saline weathering (mainly lithic and vitrified clay AICA — cf. *Bondioli et al. 1984: Tab. 3* — and other classes of overfired ceramic residues); contemporaneously, the disaggregation of the included elements by salinization and the subsequent spoiling of the soil matrix conform to the processual dynamics presented in the preceding model (*Fig. 8*). The model of *Fig. 10*, therefore, indicates only the outputs of hydraulic-gravitational re-assortment, of their subsequent concentration in situ, as well as of the eventual hydraulic dislocation of the above mentioned artefacts. The alphabetic symbology adopted for the artefactual component of the three horizons of the standard saline profile (*A* = AICA; OF = other overfired clay residues) was intentionally expressed in equivalent quantities, so that the evaluation of their

spatial behaviour (vertical or dislocative) may be quantitatively checked both in terms of increment and decrement, in linked relationship with origin from the originary aggregates (A, B) to the supporting ones (B, C) and with the relative depositional outputs (hy.g. A+B, hy. A+B). For instance, horizon C, final output of erosive processes, maintains the same quantities it formerly had with the superimposition of the total amount of inclusions of the starting terms A+B (transported by mud and debris flow) and of the assemblage of the inclusions of A and B, deprived of a given fraction (hy. A+B) dislocated by channeled hydraulic transport (gullies).

## Concluding Remarks

The geo-archaeological mapping of MNSE Area displayed the articulation of the surface formation in *primary anthropic units, degraded anthropic units and sedimentary units from hydraulic and hydraulic-gravitational re-deposition*. By interfacing the geo-archaeological map with a preliminary distributional map of a complex of lithic AICA (Fig. 11; see Vidale's report on the MNSE semiprecious stone industry in this volume) we may individuate some figures of greater or minor presence or virtual absence of such indicators. The major concentrations apparently occur on sectors of slopes proximal to plateau areas; extended scatterings of lithic AICA follow the pathways of the main furrows; less concentrated clusters appear to be correlated with zones affected by mud and debris flows. Lastly, very rarefied scatterings are distributed, with decreasing order, from the summital plateau to the filling of the basal basins.

It is necessary to premise that at the present stage of the research it does not seem possible to state whether the AICA distribution in primary depositional context was spatially indifferenced or not (merely in terms of primary presence or absence). In the light of the dynamics of interaction among the main disaggregative-erosive-depositional processes we proposed, and in accordance with the outlined models of spatial-temporal range, it is possible to offer two main interpretative evidences, the first one of geo-morphological type, the second one of geo-archaeological/anthropic order, both having analytic-processual character.

1. On the slopes contiguous to the mid-slope plateaus the selective wash-out by sheet erosion of the matrix

clearly tends to concentrate the included AICA without dislocation; parts of the artefacts may selectively be captured by the gullies' channeled erosion, therefore moving downstream in extended scattering within the boundaries of the erosive furrows. Within the basal basins the rarefaction of the AICA occurrence conform to the expected hydraulic laws of gradual decrement of the capacity of transport (decrease in tractive force caused by transmission losses in the channel sediments (Wells 1980)) with the consequent deposition of the greatest majority of the artefacts along the gullies' sides and basal lobes, while the residual elements reaching the channels result to be covered by the prevailing medium-fine sediment in transport. On the summital plateaus, finally, the prevalence of saline weathering processes and the almost total absence of erosion explain the predominant presence of accumulations of disaggregating materials, obliterating the eventual sub-surface presence of AICA. Such a morphogenetic system operating in the MNSE Area — and presumably in wide sections of the Moenjodaro compound — unavoidably stresses the probability to find the greatest AICA concentrations in the sloping zones peripheral to the various mounds (without considering, in this perspective, the eventual chronological differentiations).

2. The analysis we carried on till now necessarily leads to consider — although in the light of our models — the actual behaviour of the interactive actions of saline weathering and hydraulic-gravitational erosion, determining the progressive dismantling of a complex anthropic structural aggregate. Such natural processes, although "constrained" or "channeled" by a well defined urban network, cause an erosion that, removing the matrix, redeposit "in situ", but always at an inferior altitude (cf. Fig. 10) the artefacts that cannot be chemically attacked (AICA and other overfired clay residues). Concerning the relationship between AICA and originary geo-archaeological units, the artefacts, dislocated by channeled water action, may be considered in terms of simple noise.

In short, although at the present stage of the research we cannot evaluate the chrono-stratigraphic thickness of the removed fractions, it may be stressed that the prevailing factor turns out to be the dismantling, across different localizations, of the less structured bodies (3), namely:

A. "Horizontal figures", corresponding to eventual trampling floors, residues of domestic/industrial activities abandoned on pavements, and dumps, with an analogous functional ambivalence, transported in areas presumably contiguous/peripheral and anyhow no more in activity. Such deposits, rich in artefactual remains related to craft activities — in spite of their spatial and stratigraphical variability, must be deemed as the most specular, and so diagnostic, indicators of the performed transformational sequences: the above mentioned deposits because, cleared from the matrix,

maintain in situ the residual evidence of the activities; the dumps, although characterized by a minor grade of definition, represent *cumulative* outputs of the same events and may reliably postulate nearby activity areas. B. "Structural fillings" corresponding to structural raisings of pavements or cubing inner deposits of whole rooms, with the purpose of re-structuring dwelling complexes (houses or quarters) up to produce wider alterations of the urban network. In the framework of such re-structurations — different in time and space — it clearly results that moving from the limited transformation of a domestic space to the alteration of an urban sector, the valence of the operations changes exponentially, determining corresponding alterations in the planning dimension of the materials' removal, as well as in the localization of the drawings (as a rule formed by secondary anthropic deposits, or by formations intentionally changed into secondary ones).

For the purpose of the present study we may thus postulate that the more such operations were localized and small-sized, the more the relative fillings will turn out diagnostic of the relative activities, and, as a consequence, the more reliable will be the AICA evidence uncovered by erosion. We should not anyhow forget that (differently from the figures of type A.) it is not automatically possible to assume a proximity of drawing from the activity areas in relationship with the fillings' allocation. Locally, the different nature of the fillings observed in the MNSE Area (units G, H, I) occurring in closely contiguous sectors (but not necessarily contemporaneous) may be taken as an example of the above discussed genetic variability.

This complex of analytical and hypothetic-deductive observations leads to the inference that the surface output in the MNSE Area and other localizations of the Moenjodaro mounds corresponds to a *palimpsest* — more or less accentuated according to the degree of degradation the sites underwent — conceived as a *cumulative summation* of a portion (whose extent now we cannot evaluate) of deposits possibly different both from the functional and the chronological viewpoint.

In this phase of preliminary research we decided to try to lay down the basic terms of the question, postponing the perspective of a more critical analysis and the relative generalized spatial-chronological-functional models to a future increment in the available evidence.

An essential contribution will result from the operations of interfacing among AICA distribution and geo-archaeological units, already begun on the field with a portable computer together with L. Bondioli and M. Vidale. A further step will be represented by the future field research planned for winter 1985/86; in this phase the research will be addressed, also through experimental texts with short-medium time resolutions, to the control of the *time-erosion* relationship, as well as of the interrelationships between "pure" geo-archaeological units and quantitative/qualitative presence of

AICA, thus defining a graduality between the areas providing reliable indications on craft activity and the "secondary" ones, more contaminated by the summation of the erosive dynamics and the archaeological *palimpsest*.

#### Footnotes

1. The geo-archaeological survey has been carried out by C. Balista, while the interconnection between geological and anthropic aspects has been developed by G. Leonardi, who also effected the construction of the various models, fruit of a continuous scientific interchange.
2. With the term "primary anthropic units" we specifically define any non-post-depositional anthropic deposit. We took into account only the anthropic formations encountered in the site under examination.
3. As a matter of fact, from this viewpoint, walls and platforms, either in fired or mud brick, may be considered noise in their quality of non-potential distributing terms of AICA.

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Fig. 1

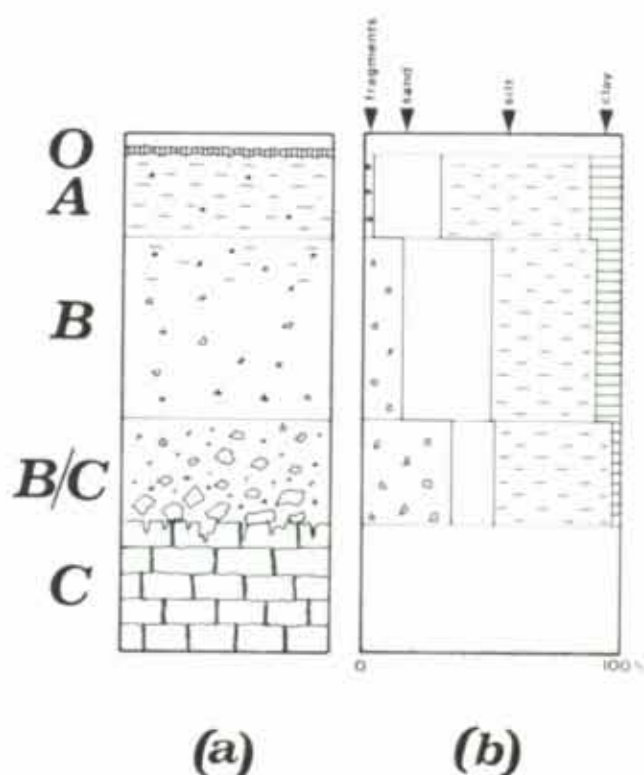


Fig. 3

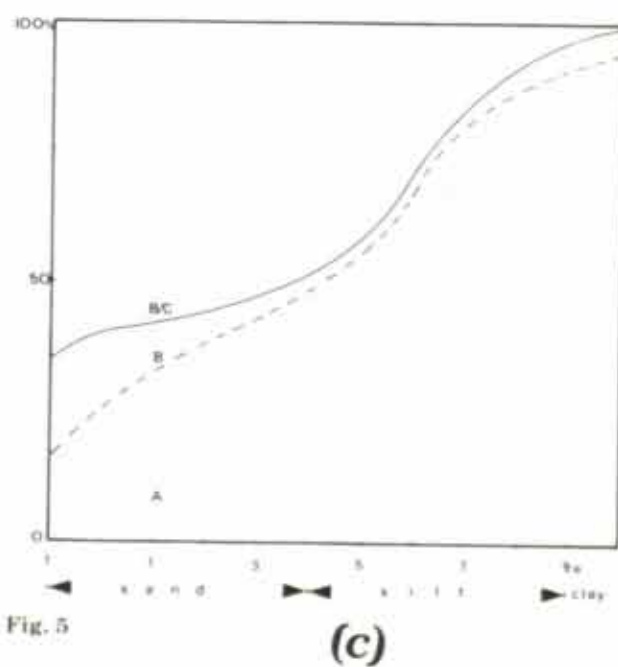


Fig. 5

Fig. 1 Aerial view of the Moneer South-East Area from the hot-air balloon (by courtesy of M. Jansen).

Fig. 3 Partial view of the MNSE Area.

Fig. 5 Simplified scheme of the main geo-archaeological processes active in the examined site (C. Balista).

Fig. 2, 4 ▶

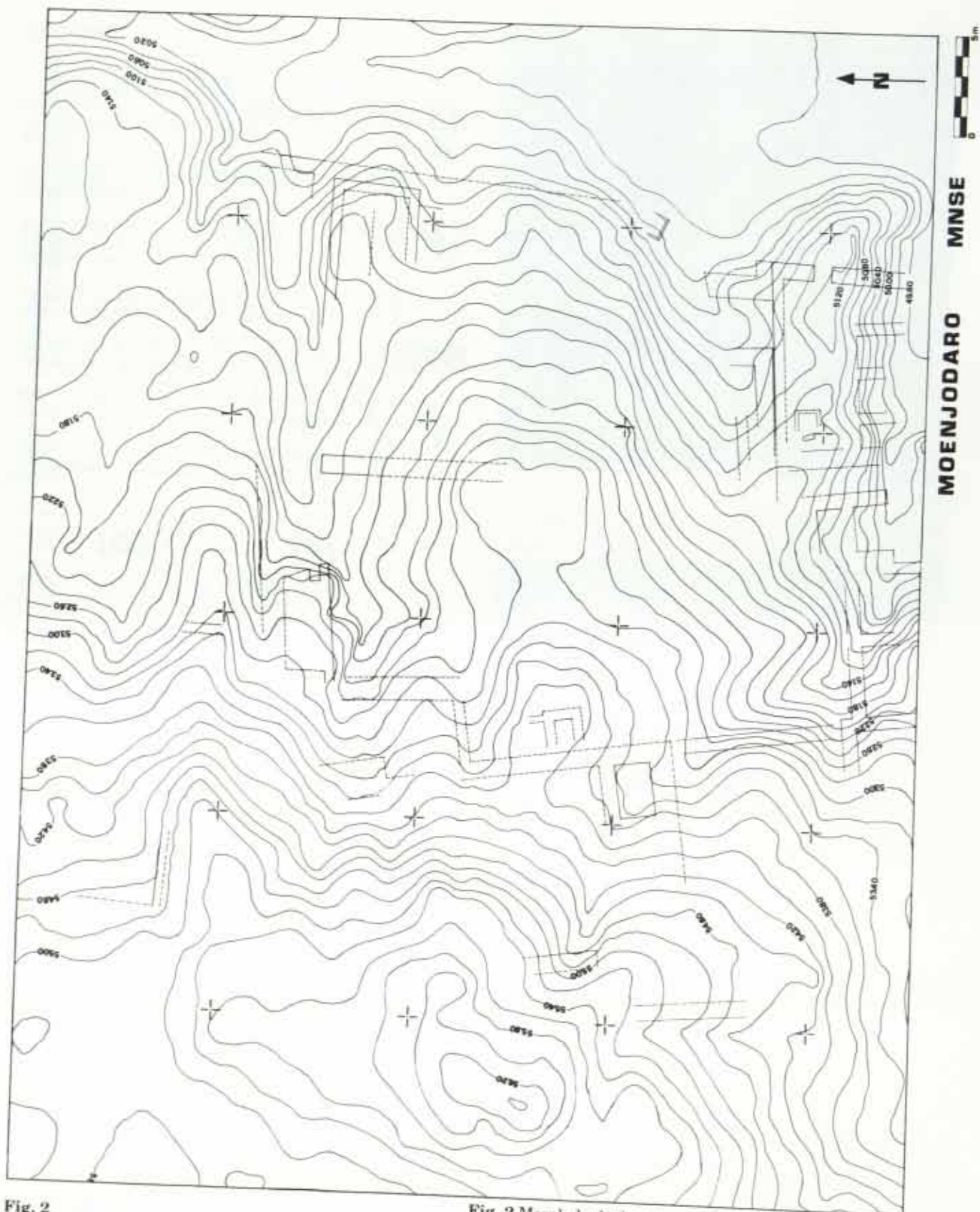


Fig. 2

Fig. 2 Morphological setting of the MNSE Area (drawing by T. Urban, M. Vidale, L. Mariani).

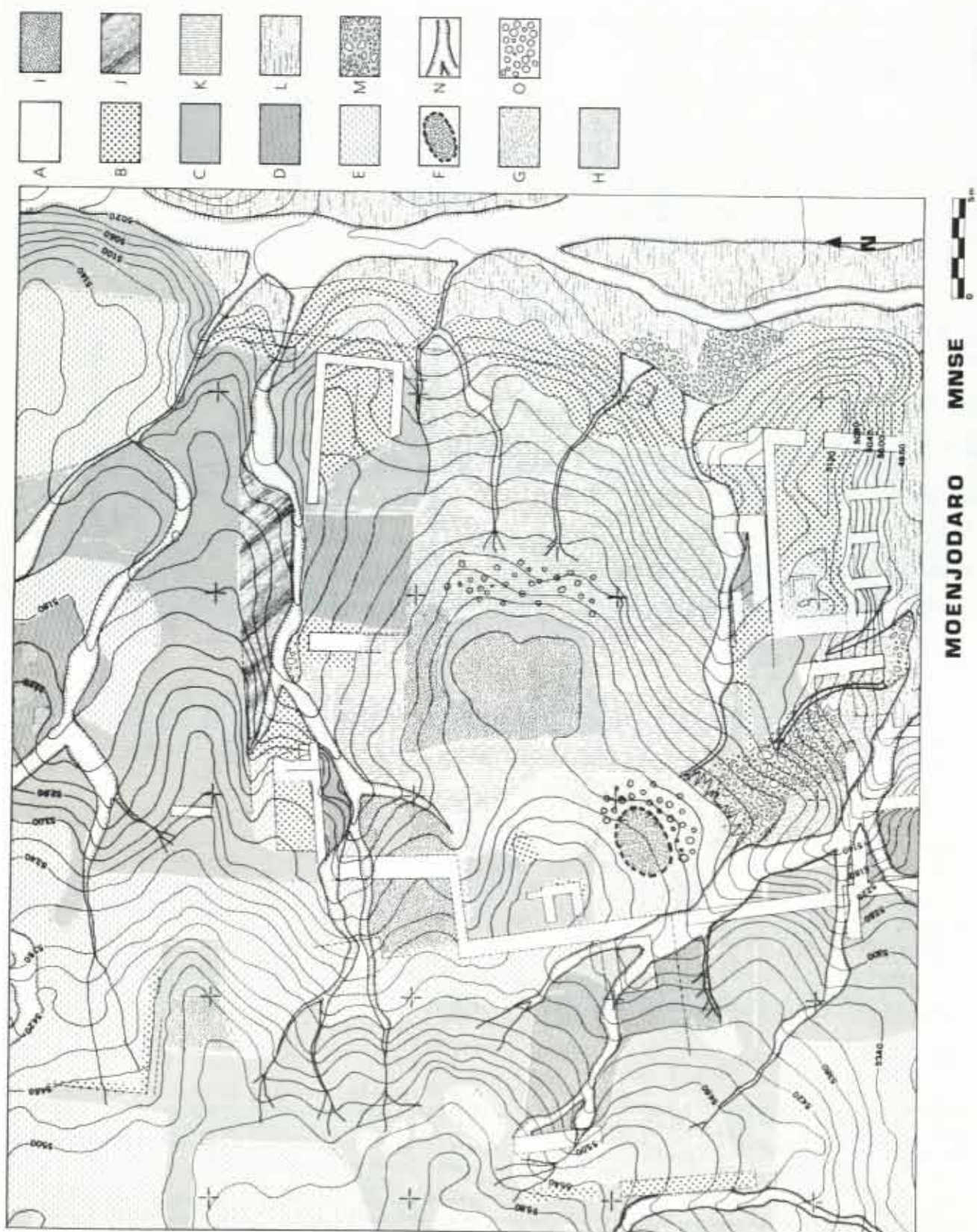


Fig. 4

Fig. 4 Geo-archaeological map of the MNSE Area (survey by C. Balista, drawing by R. Pagan).

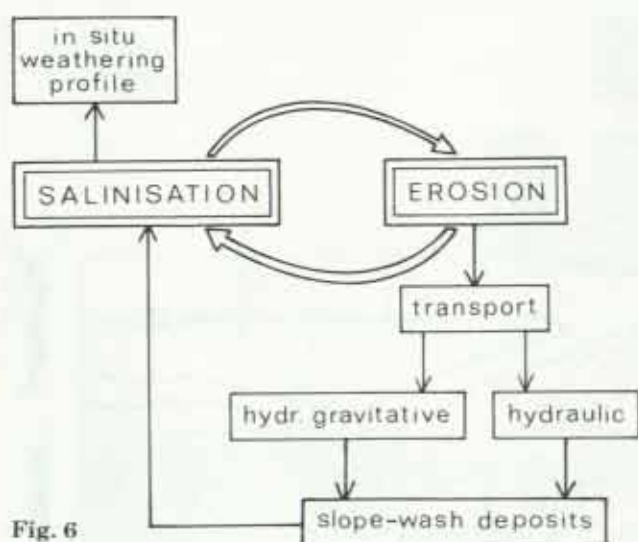


Fig. 6

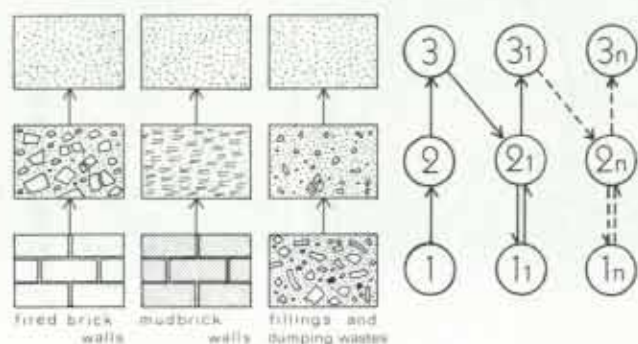


Fig. 7

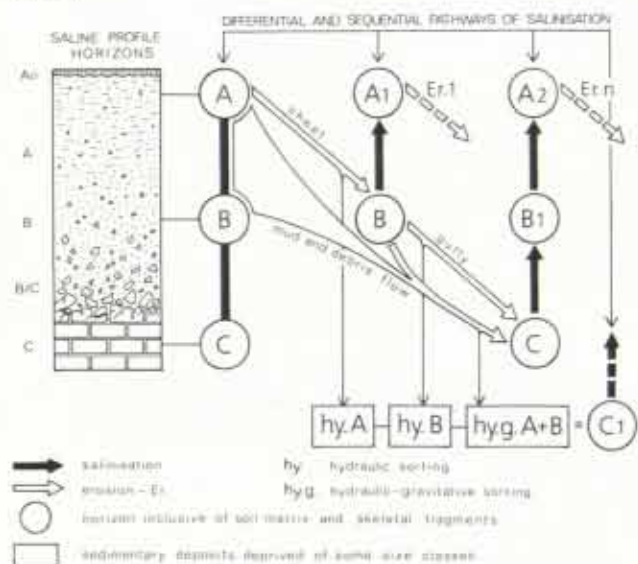


Fig. 8

Fig. 6 Model granulometric diagrams relative to salinization process: a. saline weathering profile; b. percentual distributions of the typical textural classes; c. cumulative granulometric graph (C. Balista).

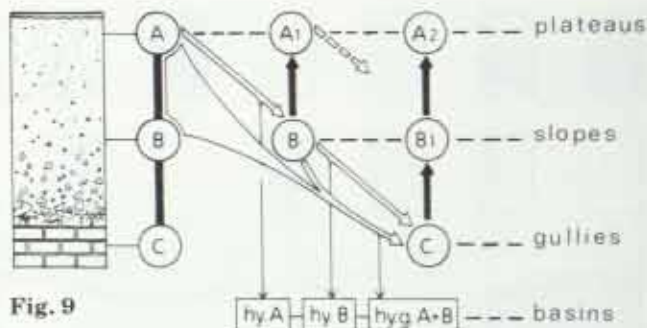


Fig. 9

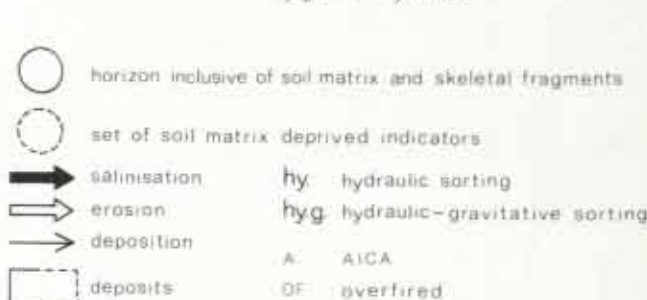
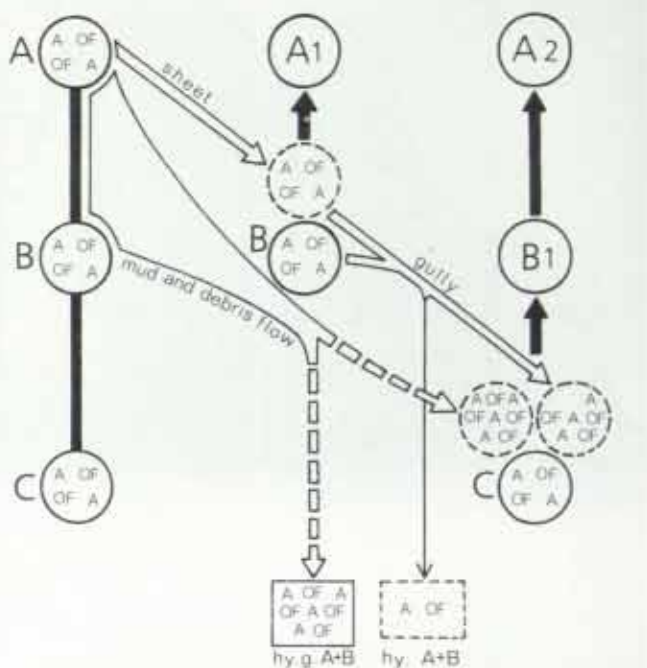


Fig. 10

Fig. 7 Simplified scheme of the cyclic evolution of saline profiles, re-started by water-erosion processes (G. Leonardi).

Fig. 8 Model of the interaction between salinization and erosion processes (G. Leonardi).

Fig. 9 Correlation scheme on the graphic and conceptual ambivalence of the models in Figs. 8 and 10 (G. Leonardi).

Fig. 10 Model of the re-deposition and dislocation of Archaeological Indicators of Craft Activity (G. Leonardi).

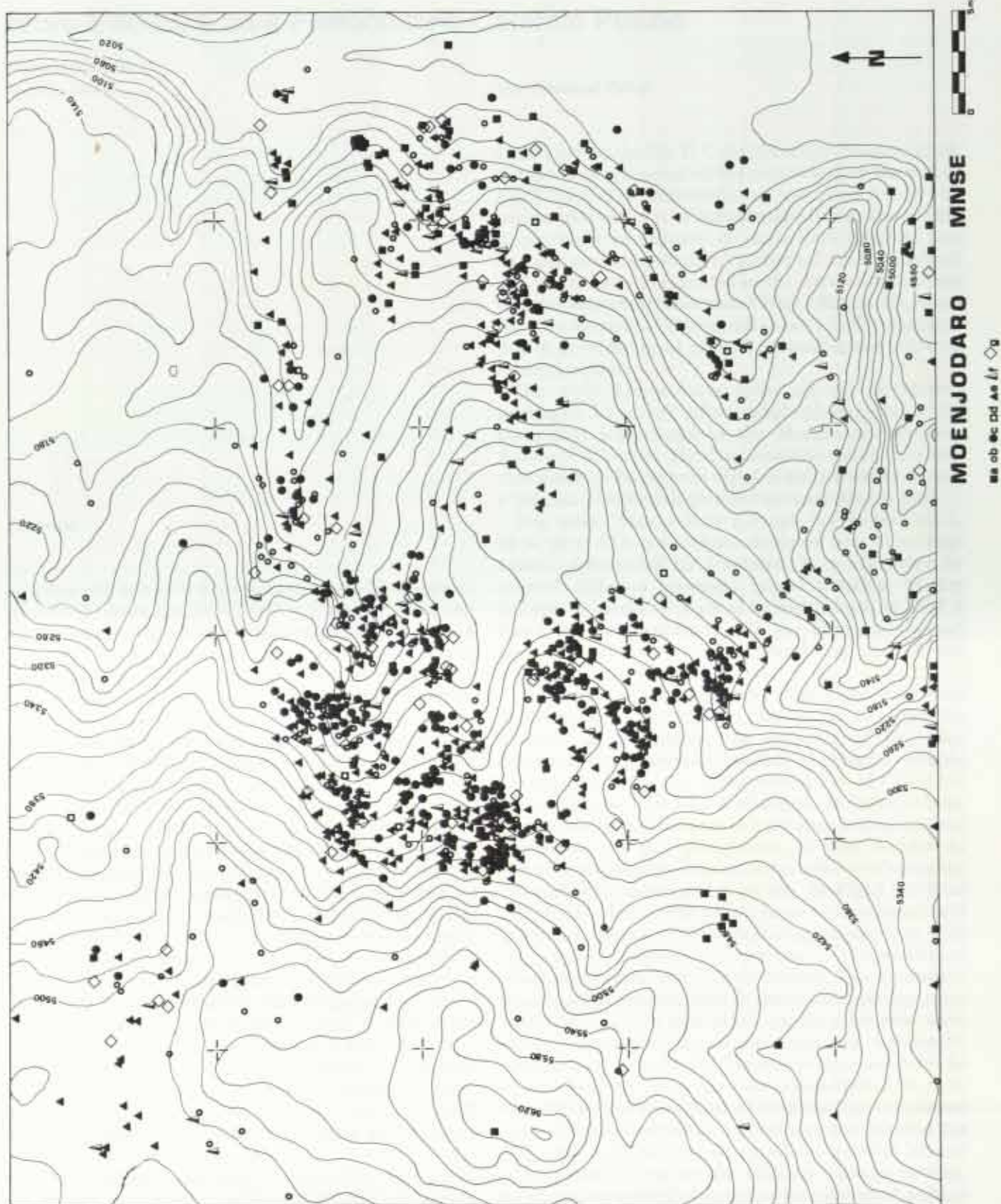


Fig. 11

Fig. 11 Distributional map of selected classes of lithic AICA in MNSE Area (for the explanation of the symbols see Vidale's report on the industry of MNSE Area, Fig. 4).



# More Evidence on a Protohistoric Ceramic Puzzle

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## The Residual Order

I came across the DK-B, C slag in one of the excavation dumps of this section of the compound at the end of April 1984. The importance of the piece lies in the substantial amount of information it provides on the employment of saggars in stone-ware bangles' production, according to the hypothetical models outlined in a contribution presented in the first volume of our Interim Reports (Halim and Vidale 1984: 91-95). Since the very moment of this fortuitous (?) find it was clear that it provided good ground for testing our previous interpretations.

Our field season was over, all our equipment packaged. I couldn't take a single photograph of the piece that was stored in the Moenjodaro Museum Reserve Collection. The documentation work on which this report is based was effected by the writer during a brief stay at Moenjodaro in February-March 1985.

The piece (Figs. 1-2) is a rough polyhedral block, 23 x 19 x 13,5 cm., whose surfaces are, to a large extent, determined by fractures. It is composed by several different elements joined together by the collapse pressure in state of incipient melting, and it bears, in correspondence with the elements' contact surfaces, substantial voids preserving part of the original morphological features.

The collapse producing the slag mass has been described as a disordering process. In the slag the disorder is incomplete; the analysis of its inner components still provides good insights on the collapse dynamics and, as a consequence, on the original setting of the kiln load's elements. In other words, we are dealing with a true sub-primary archaeological deposition. In this perspective, it was decided to describe the piece enhancing its character of complex, "stratified" archaeological context. In Fig. 2 a frontal and a side view of the object have been selected and reproduced like two archaeological guide-sections, with the purpose of delineating the sequence of depositional events producing the slag formation. This procedure has been followed in spite of the evident divergences, both physical and relational, existing between such ceramic deposition and a more common sedimento-archaeological context. These divergences will be encountered all along the piece's description. A first, immediate problem, rather unusual in a normal archaeological section is orientation: one handles the slag and can't figure out in which position should it be placed to restore its original collapse setting, as no technological element or gravitational feature is immediately clear enough to give reliable indications. The orientation of the piece in Fig. 2 (arbitrarily) depends upon pre-existing functional models, as a

## Disorder

Interior of a kiln in the town we now call Moenjodaro, about 4000 years ago. The chamber is heavily breathing heat waves, maintaining the inner temperature around 1000° C, floating around the carefully arranged elements of the kiln's load. Suddenly, an error in the fuel alimentation or in some other particular of the extremely sophisticated organization of the firing system results in a violent rise of the temperature to more than 1100° C<sup>1</sup> in a restricted sector of the firing chamber. The ceramics so painstakingly formed, dried and piled together with the interspacing elements instantly begin to soften, soon reaching a plastic state. The piles start to fall one after the other, pulling down piece after piece the surrounding arrangement toward the overheated core, where they melt like wax into an amorphous bubbling mass. Part of the elements, not directly affected by the burst, fall down still partially maintaining a shape. At the end of this small protohistoric catastrophe, the floor of the kiln recalls some bizarre, proteiform blackish sculpture.

We don't know to what extent such a view could stimulate the aesthetic appreciation of the potter, who had to destroy the glass-hard formation by breaking it with strong blows in order to re-utilize the lower part of the infrastructure or, perhaps, to resign himself to start constructing a new one. We know that, no more than fifty years ago, the remains of the kiln or the pieces of the slag mass were unearthed by the workers excavating the DK-B, C sections of Moenjodaro, just to be discarded on the spot by the modern archaeologist looking for something far more exciting than a black piece of burnt clay.

fragmentary pile of three partially melted pottery bangles has been orientated at the base of the block (Halim and Vidale 1984: Fig. 63).

This orientation has also the advantage of presenting part of the superimposed elements in a sub-horizontal arrangement, like in a normal stratigraphy. Given the irregular nature of the piece, it will be observed that, in the following description, attention is rather freely focussed on whole ceramic components as well as, sometimes, on surfaces having distinctive technological features.

The following discussion of the slag's components is more descriptive than analytical, providing the basic points on which the subsequent interpretations will be founded.

- (1) Fragmentary slag element, strongly bubbled, adhering to the underlying surface (2) with a possible functional surface. The remaining portion has now a lens-shaped section (Fig. 3).
- (2) Vitrified chaff-tempered surface, in which the burnt vegetal particles created a network of angle-like structures, very fragile and easily attacked by salt (Fig. 3). This surface characterizes, in all the observed cases, the outer coating of the saggars called "Coated Carinated Jars" (CCJ) (Halim and Vidale 1984: 65; Figs. 5, 6).
- (3), (4), (5) Layers with sub-horizontal, slightly undulated setting, having uniform structure, with very scarce macroscopic inclusions. (4) and (5) show a strong increase in pores and micro-bubbles often assuming flat elongated shapes, expressing the tension-squashing lines affecting the ceramic walls in the collapse. The three formations are deeply penetrated by irregular cracks. (3) apparently had been formed by the melting of the chaff-tempered coating with the relative CCJ inner wall. The lower section of (3) is compact and hard enough to recall the wall features of these latter saggars. All the three episodes are substantially very similar and could suggest the same formation dynamics (Figs. 3, 6).
- (6) This element, mainly visible in the side view of Fig. 2, is formed by the partially melted wall of the saggars previously defined "Coated Sub-cylindrical Bowls" (CSB), whose association with stoneware bangles' firing had already been ascertained (Halim and Vidale 1984: 91-95). In this case, the deformed wall (6) (Fig. 4) is squashed against the wall of the remains of the up-turned CSB (7). (6) still locally retains the outer coating features, while in the upper parts, in contact with (5), it almost completely loses any shape, transforming into an amorphous bubbled mass (Fig. 4).
- (7) This formation is produced by the outer chaff-tempered coating of the CSB (8) — (9) (Figs. 4-6). It apparently covers the whole saggars; it is distinguished from the superimposed formation (5) due to the circular shape of the inner bubbles (indicating absence of tensional stress) as well as by a darker hue.
- (8), (9) Wall and lid fragments of CSB still retaining part of their morphological features and their primary setting (Figs. 5-6). These elements, unaffected by major distortion like the similar episodes (12), (14), (16) conform to the (morphological) and textural characteristics already described for CSB fragments in the already mentioned report. It is actually possible that at least part of the CSB fragments recovered on the surface were detached from similar slag pavements.
- (10) Apparently in horizontal contact with the group (7), (8), (9) and with the fragment (11), (12) this element is the remaining portion of a CSB showing the distinctive features of the outer coating. The fracture surface reveals an undistinguished bubbled mass (Fig. 6).
- (11) Fragments of outer coating adhering to a CSB wall (Fig. 6).
- (12) Fragments of CSB joining the outer coating of (8) — (9) with (10) (Fig. 6).
- (13) Outer coating of the best preserved CSB. In the area of contact with (7), the outer coating of CSB (8) — (9), the limit between the two elements is hardly recognizable. (13) is well visible all over the exposed sections of the saggars (Figs. 4, 5, 7).
- (14), (15), (16) The first element (14) is a fragmentary up-turned CSB, preserved for something more than one half of the total, showing a slightly S-shaped contour (cf. Halim and Vidale 1984: Fig. 67, i-l). The saggars is still assembled in its primary setting with the fragmentary lid (16), thus enclosing the couple of superimposed stoneware bangles (15) (Figs. 4, 5, 7). Both the saggars and the lid show a strongly concave profile. This feature could well have been enhanced by the collapse pressure, but analogous pieces were recorded from the surface (Halim and Vidale 1984: Figs. 72, d; 74, d). The two bracelets share the same ovoidal section; looking at the fracture surface, the contact between the bracelets appears to be marked by an almost indiscernible line, running across a material strikingly homogeneous from the textural view point. The CSB elements (13) — (16) seem to be placed directly below the upper CSB (7) — (9).
- (17), (18) Remains of other two CSB documented by the usual chaff-tempered outer coating. (17) appears heavily squashed from the upper weight of the series (7) — (9) and (13) — (16); (18), exactly like (10), present an undistinguished bubbled material on the fracture surface (Fig. 7).
- (19) Homogeneous, thick layer intensively bubbled, looking analogous to the episodes of the series (3) — (5) (Fig. 7).
- (20) In phase of incipient melting, this thick compact formation is characterized by a still recognizable

granular texture and by a scarce presence of bubbles. Its inner structure, showing an irregular superimposition of sheet-like formations, recalls the base part of *CCJ*, hand-formed by pressing sheets of clay into a chuck (*Halim and Vidale* 1984: 81). Stratigraphically, this element is directly in contact with (4) and, perhaps, in phase with (5) (the exact nature of the contact with this latter formation is hardly definable) (*Fig. 2*, dashed line).

- (21), (22) These episodes, morphologically analogous to (19) as well as to the upper series (3) — (5), are distinguished on the side view of *Fig. 2* by a noticeable thickness, produced by an intensive thermal dilation, combined with inner circumvolutions. Such a structure is produced by the collapse and the folding of a melted ceramic wall, pushing and covering the group of *CSB*. (22), having a chaff-tempered surface identical to the one described for (2), would correspond to the upper element (3) (*Fig. 8*).
- (23) Chaff-tempered coating with angle-like surface structures identical to the ones described in (2), defining the episode (22) as a surviving portion of *CCJ* wall (*Fig. 9*).
- (24) A series of at least three superimposed terracotta bangles sticking to the surface (23), recalling the base arrangement of *CCJ* in primary setting. The small pile of bangles appears to have been disturbed by external additions, distortion, melting and breaking (*Fig. 9*).
- (25) This unit represents the final, "static" output of the collapse sequence, in the form of a strongly vitrified, dropping surface (*Fig. 9*) generated by the melting of an area immediately close to the piled bangles (*Fig. 8*). It indicates a prolonged, direct exposure to the main heat source; on the other hand, the dropping direction offers the only one indication on the "absolute" orientation of the block in the context of the collapse. Judging from the small surviving vitrified area, as the clay drops are falling in the same direction of the bangles' diameter, the pile could have been reverted; as a consequence, the row(s) of *CSB* containing the stoneware bangles were possibly scattered over a sub-horizontal, irregular surface.

#### Back to the Order?

The best preserved *CSB* visible in *Figs. 4, 5, 7* shows the firing module of a pair of stoneware bracelets in primary context, confirming the model previously hypothesized

after the evidence provided by some bangle pieces bearing remains of the base of the saggar (*Halim and Vidale* 1984: *Figs. 71-72*). The morphological and dimensional features of the saggars, in spite of the heavy distortion, conform to the specimens previously described, whose height allowed the insertion of a number of bracelets ranging from 2 to 4-5. The number of 2 attested by the DK-B, C slag would match with saggars having dimensions analogous to the bowls illustrated in *Fig. 67, e, i, l* of the above mentioned report and it is rather close to the number of 3 we formerly estimated as an average value.

A new particular revealed by the *CSB* (13) — (16) is the strongly concave profile of both the lid and the base of the saggar. In this case, such a feature could have been designed to keep more safely in place the two bracelets after the saggar was closed. A datum contradicting the evidence we previously gathered is the presence, all round the *CSB*, of a continuous outer coating, completely covering the vessel from the lid to the bottom, as well as of a lid for every observable *CSB*. If the bowls had to be piled one over the other, this would have determined an additional coating-and-lid diaphragm between vessel and vessel.

As a matter of fact, a fragment of a *CSB* pile recovered in AA. 28 (*Halim and Vidale* 1984: *Fig. 72, c*) has shown a case of direct superimposition of the bowls without any lid of chaff-tempered coating. These divergences should be ascribed to a certain range of technological variability already observed in other features of the saggars' assembling system (*ibidem*: 84).

The analysis of the slag revealed that the described *CSB* is only one element of a more complex relational aggregate. The diagram in *Fig. 10* shows the relationship of superimposition existing among the various components of the slag, as they appear from the graphic representation of *Fig. 2*. According to our reconstruction, the block contains the residual evidence of not less than 7 *CSB*. A relationship of direct superimposition may be observed in the sequence (17) and (18), (13) — (16), and (7) — (9), to be interpreted as the residue of a cylindrical pillar of superimposed *CSB* fallen down and partially melted in the collapse. Containers (10) and (11) — (12) on one side and (6) on the other one appear now in horizontal contact with the upper group (7) — (9). Do they represent the upper section of the pillar displaced by the collapse or do they belong to some contiguous series? The simple inspection of the slag can't provide a reliable conclusion; the number of *CSB* present in the block (if the estimate is correct, given the intense distortion of the pieces) would somehow point to the second alternative.

As stated above, the pile of *CSB* fell probably down over a sub-horizontal surface. The humped profile of the bowls in the main row would suggest, moreover, that the falling pile crashed down onto an underlying body. The central axis of the piled terracotta bangles (24), adhering to the outer chaff-tempered coating (23),

results displaced of about 90° from the inner axis of the fallen row of saggars.

In the diagram of Fig. 10 it may be observed how the CSB cluster by series of folding episodes (4), (5), (19), (20), (21)), rather homogeneous from the morphological viewpoint; the element (20) may hypothetically be referred to the features of the basal section of CCJ. The parallel series (2) — (3) and (22) — (23) have been interpreted as fragmentary traces of outer coating of CCJ, locally retaining residues of the suspensory bangles forming the basal supporting system. All this evidence points thus to the following interpretation: the collapse of the kiln's load produced pillar(s) of CSB embedded, in melting, by walls and bottoms of CCJ. This would implicate two possible alternatives: either the pillars of CSB were placed in the kiln's chamber side by side with the larger CCJ, or they were inserted *inside* these latter saggars. The diagram of Fig. 10 expresses this hypothesis, taking into account the possibility that the two parts of CCJ outer coating visible on the edges of the block actually belonged to the same coated container. The discussed evidence leads to the hypothetical reconstruction visible in Fig. 11.

A pillar of 5 superimposed CSB, each containing 2 stoneware bracelets, externally chaff-temper coated, has been inserted in the hypothesis of reconstruction of CCJ assemblage (Halim and Vidale 1984: Fig. 62). The characteristics of the inner CSB pillar are directly resumed from the DK-B, C slag. The main problem lies in the modular features of the pillar: in the reconstruction I have assumed for the interior of CCJ an available space of about 15 cm. of diameter x 30 cm. of height, in which 5 assembled units 6 cm. high have been arranged. As the bowls' dimensions are rather variable, the presence of 5 CSB and, consequently, the total number of 10 stoneware bracelets per sagger is wholly conjectural, although my estimates would deny the possibility of the presence of more bowls in such a restricted space. The apparent occurrence of 7 CSB in the block, calling for an external explanation, forms thus an anomaly in the proposed reconstruction. On the contrary, the function of the supporting cones E-F, which could hardly be understood in the framework of our previous model, as the cones can't stand any weight from the closure apparatus (Halim and Vidale 1984: 84), could better be explained with the aim of centering and fixing the pillar to the CCJ walls.

Lastly, it remains to discuss the controversial point of the greenish deposition recovered in 1982, apparently in primary context, on the bottom of one of the complete CCJ specimens (*ibidem*: 89). Again, we still have no safe ground for discussion. We are actually planning to re-analyze samples of the recovered material eliminating all the components which could be ascribed to post-depositional contamination. If we should get, in future, clear evidence of any type of raw material being fired inside the larger saggars, this would noticeably weaken the reconstruction hy-

pothesis of Fig. 11. Any other statement on the subject closely depends upon the developments of the archaeological research.

The DK-B, C slag has demonstrated the primary association of CCJ with CSB, confirming the constant association between the two types of indicators observed on the surface of the relative activity areas. In this perspective the hypothesis of functional connection resulting from this paper appears to have, at the present stage of the research, normative character: in spite of its unconventional, labyrinthine complexity it accounts for most of the observed and/or intuited regularities. I don't think it will be possible to continue to play with the puzzle without re-opening the lid of the box, i.e. to go back to the field and look directly to the stoneware-firing kilns *in situ*.

## Footnotes

- 1 (Schneider and Büsch 1984: 127).

## Bibliography

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Fig. 1

Fig. 1 Moenjodaro, DK-B, C dumps. View of the slag with the Coated Sub-cylindrical Bowl enclosing the stoneware bangles in central position.



Fig. 2

Fig. 2 Front view (left) and side view (right) of the DK-B, C slag. The two views of the object are considered like sections to describe the relationship of superimposition among the inner components.

Fig. 3 Close up view of one extremity of the slag showing a fragment of chaff-tempered coating (2) characteristic of Coated Carinated Jars under an allocthonous element (1).

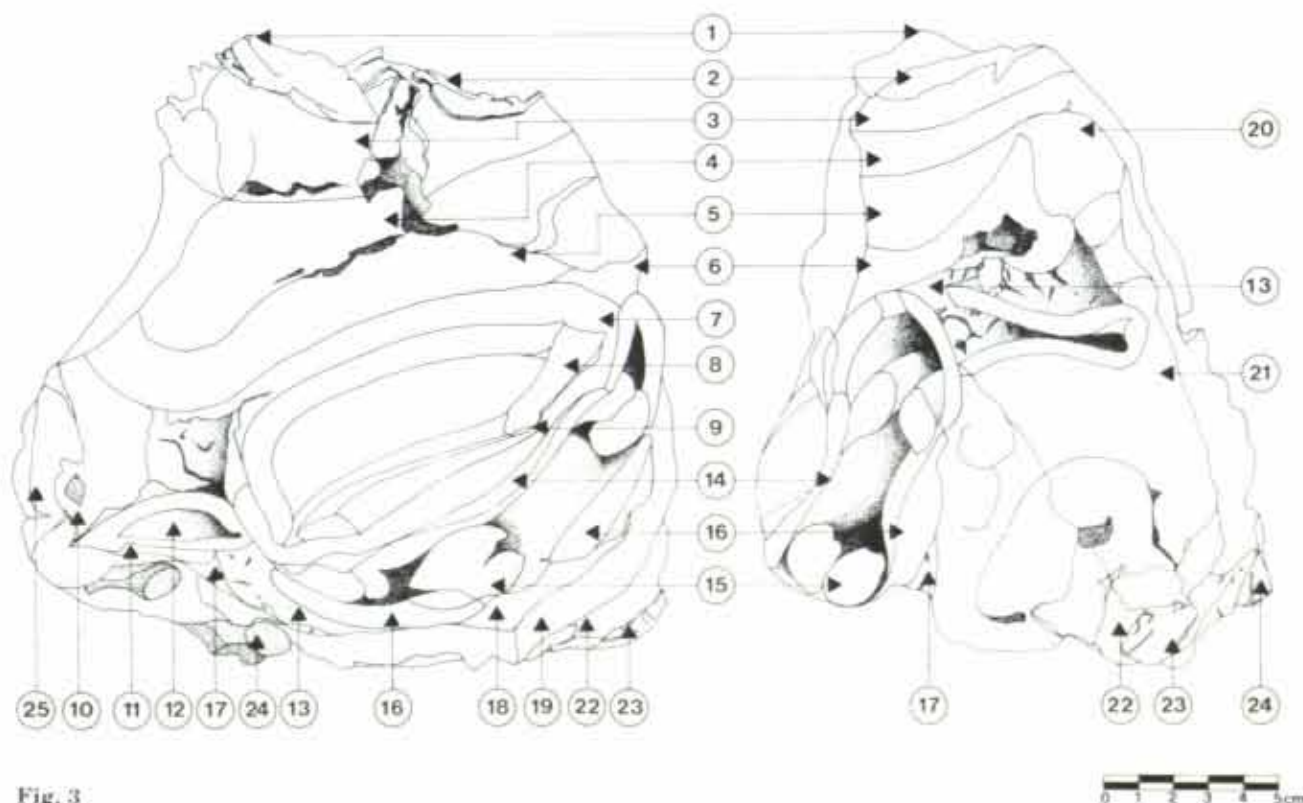


Fig. 3



Fig. 4

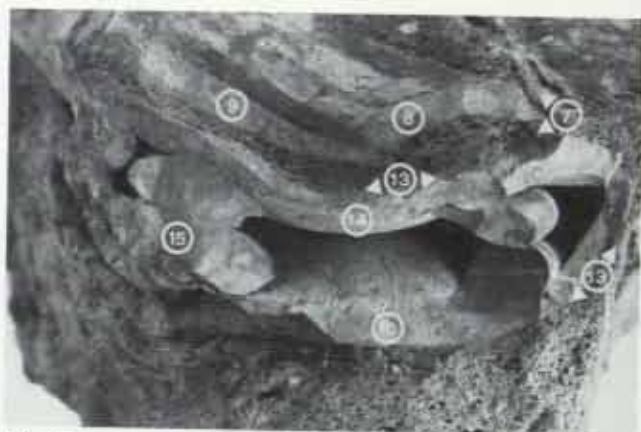


Fig. 5

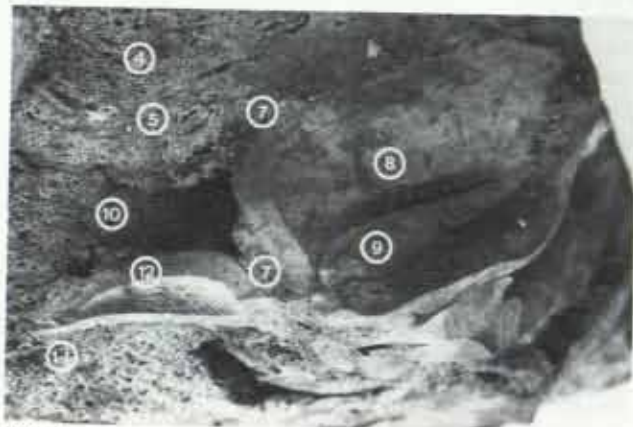


Fig. 6

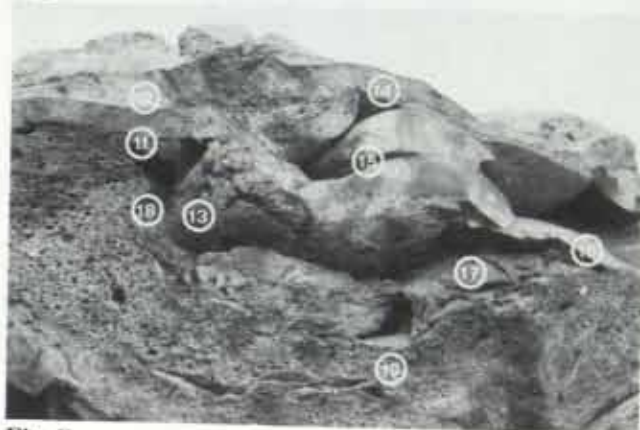


Fig. 7



Fig. 8



Fig. 9

**Fig. 4** Side close-up view of the CSB retaining the stoneware bangles, showing the position of the partially melted CSB (6) in horizontal contact and in partial superimposition.

**Fig. 5** Front close-up view of the central CSB. Note the concave profile of both the lid (16) and the bowl (14).

**Fig. 6** Close-up view of the CSB (7) — (9), showing the horizontal contact with CSB (11) — (12) and (10).

**Fig. 7** Close-up view of the central CSB, showing the position of the lower elements (17) and (18), strongly squashed and transformed into a shapeless mass.

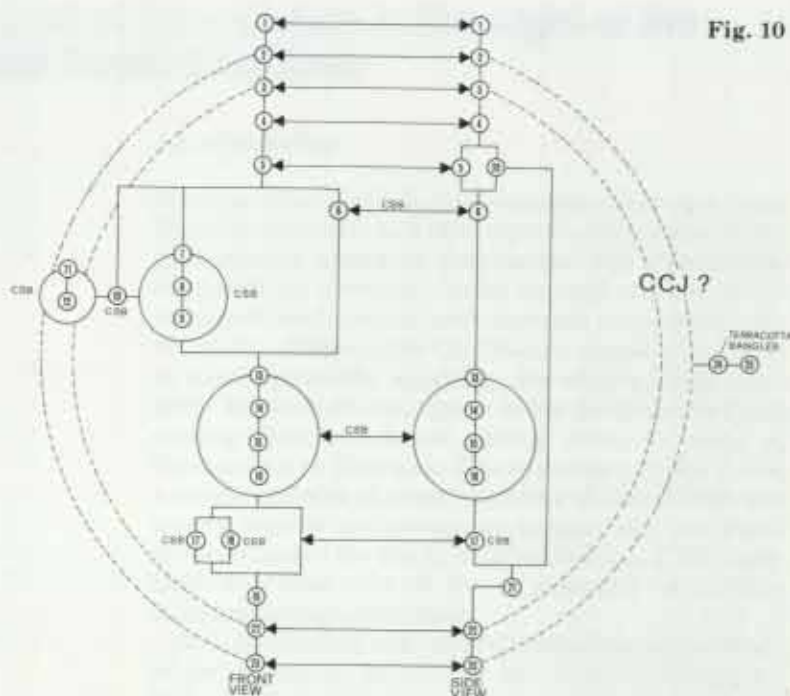
**Fig. 8** Close-up view of three fragmentary terracotta bangles (24) piled and adhering to the outer chaff-tempered coating portion. Such a feature is distinctive of the basal supporting system of CCJ. Note, like in the case of Fig. 1, the presence of external additions deforming the piled bangles' structure.

**Fig. 9** Close-up view of the opposite face of the bangles' pile in Fig. 8. Note the position of the third bangle, partially removed from the pile, as well as the melted clay whose dropping direction demonstrates the sub-horizontal setting of the block at the end of the collapse.

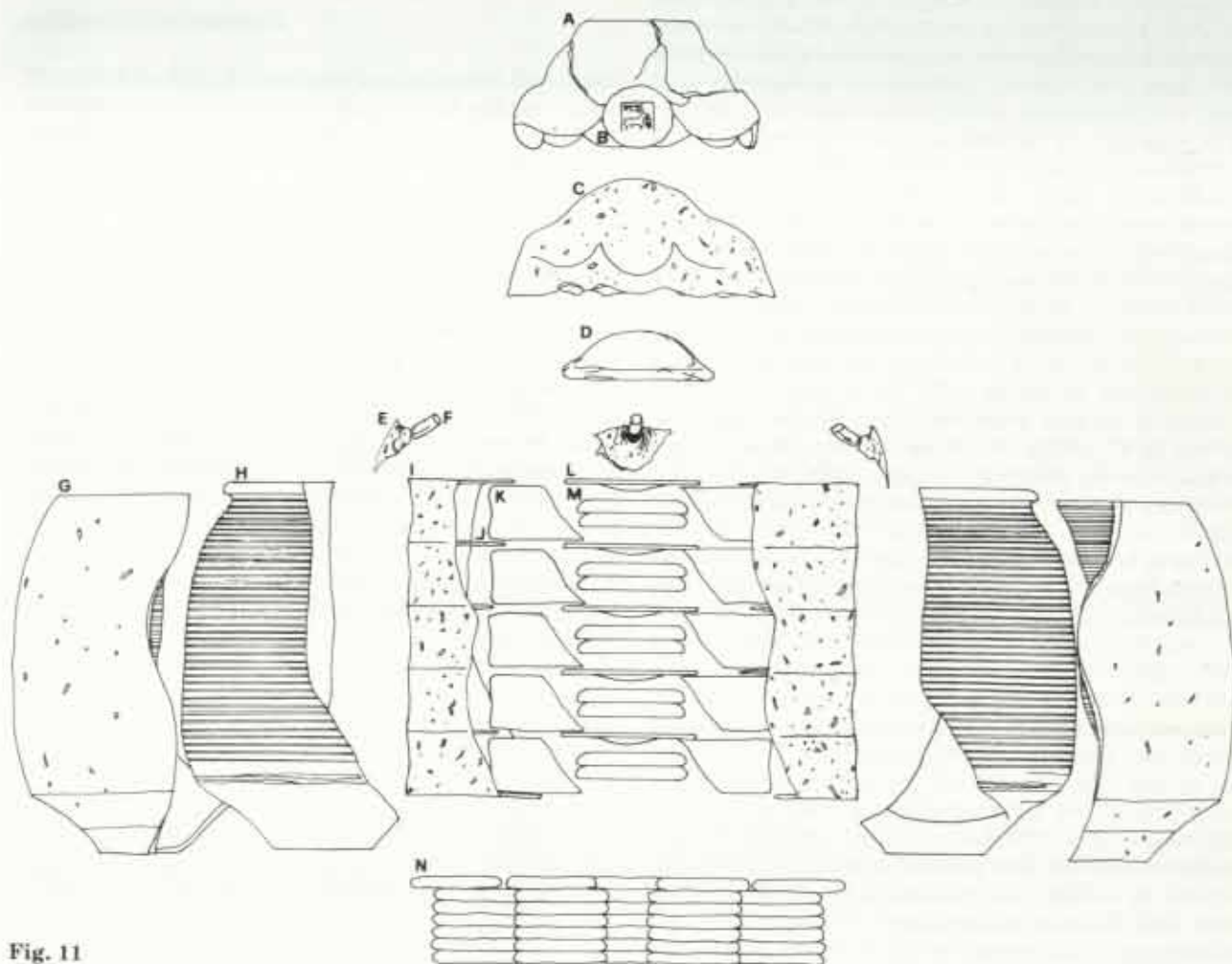
**Fig. 10** Diagram showing the relationships of superimposition among the elements enclosed in the DK-B,C slag. Arrows mark relationship of identity between stratigraphic elements occurring both in the front as in the side view of the piece in Fig. 2. The dashed semi-circumferences express the hypothesis that the fragments of chaff-tempered coating retained by the block have to be ascribed at the same CCJ.

**Fig. 11** Reconstructive hypothesis of the stoneware bangles' firing apparatus in the light of the DK-B,C slag evidence.

- A: upper capping;
- B: sealing with unicorn stamp seal impression;
- C: intermediate chaff-tempered coating;
- D: pottery hemispherical lid;
- E: chaff-tempered supporting cone;
- F: fragmentary, re-utilized terracotta bangle;
- G: red-slipped, chaff-tempered outer coating;
- H: Coated Carinated Jar;
- I: chaff-tempered outer coating of the Coated Sub-cylindrical Bowls pillar;
- J: intermediate chaff-tempered diaphragm;
- K: Sub-cylindrical Bowls;
- L: lid;
- M: stoneware bracelets;
- N: network of supporting terracotta bangles.



**Fig. 10**



**Fig. 11**



# Some Aspects of Lapidary Craft at Moenjodaro in the Light of the Surface Record of the Moneer South East Area

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## 1.1. Introduction

The trenches dug by N. G. Majumdar in Mounds I and III of Chanhudaro in February 1931 (*Majumdar* 1934) were mainly aimed to demonstrate the Chalcolithic nature of the new site. Going through the list of the recovered artefacts, the archaeologist acquainted with the study of Harappan Civilization immediately feels at home: generally speaking, the objects (*Majumdar* 1934: 40-44) could well figure in the inventory of finds coming from any house, filling, street or dump of Moenjodaro or Harappa. The occurrence in the list of a single unfinished stone bead and of some chert and copper tools is not enough to suggest any particular involvement of the site in craft production. If Chanhudaro was later selected for an extensive excavation it was otherwise motivated.

E. J. H. Mackay arrived at Chanhudaro on the wave of an increasing interest in the study of Harappan technology; to remain close to the subject of this paper, one could easily point out his growing attention to the stone-working technology measuring the space devoted to bead-making respectively in the 1931 and 1938 reports. The Chanhudaro finds represented the most indicate ground for testing Mackay's experience. The excavation report (*Mackay* 1937; 1943) evidenced how a greater part of the structures in the main mound (Mound II) were somehow connected with an intensive form of semiprecious stone manufacture, in particular with bead-making; a striking concentration of rough material, tools, waste and unfinished products found in close proximity with a complex firing infrastructure even suggested the presence of a "bead factory" (*Mackay* 1943: 41-44). The study of the collected materials, where much attention is paid to such a sophisticated artefact as the so called "long barrel-cylinder carnelian beads", includes an exhaustive reconstruction of the transformational chain partitioning the beads' manufacturing cycle. Its inner stages are clearly defined and critically connected to sets of tools and replicative hypotheses on their employment, as well as to the relative range of possible misproducts and wasters (*Mackay* 1937; 1943: 210-214). In the first report (*Mackay* 1937: 7) we are informed that a very distinctive type of drill, already found at Ur where it had been uncorrectly interpreted as an unfinished bead, was used to perforate hard stone beads (the error, shared in the beginning by Mackay, was due to the shallow circular depression visible on the tip of the tool -cf. *Mackay* 1943: Pl. LXXXVI, a, 5). These sub-cylindrical drill-heads, together with the less specialized micro-drills on blade support so common in several 3rd millennium BC bead-making assemblages, were destined, in the long run, to become the archaeological

markers of the ancient lapidaries in the protourban centers of Southwestern Asia.

If we stress the importance of Mackay's work it is because it provided the basic hardware underlying any future perspective of integrate analysis of lapidary craft in protohistorical contexts. He was able to show that one of the most important craft specializations across the protourban systems of the great alluvial plains was fully evident through the traces it left in the archaeological record; and, implicitly, that the effected correlations between archaeological craft indicators and stages of production could grant some degree of control on the qualitative/quantitative parameters of the processual chain of the manufacturing cycle. On a wider perspective, this aspect of craft specialization, conceived, according to G. Childe's (1950) paratactic mode, as a discriminant variable of protourban systems, could be experimentally observed on the field (e.g. Tosi and Piperno 1973: 5).

The Chanhudaro reports, due to the striking amount of information and the relatively systematic treatment of the data, had to remain for a long time an isolated achievement, in spite of the fact that, in Mesopotamia, microlithic industries had been already noticed in Chalcolithic contexts (Watelin 1929: fig. 5). In the following period, K. Butzer (1959) drew attention to some flint drills and related semiprecious stone assemblages which had been found at Hyerakompolis, in Predynastic to Old Kingdom contexts; Soviet scholars studying the Sub-Neolithic Kel'Terminar in the Kyzyl Kum came across intensive evidences of working floors or ateliers where turquoise beads were manufactured (Vinogradov 1972; 1973; see the literature reviewed in Tosi 1974). The geographic mosaic of 3rd millennium BC semiprecious stone working was enlarged to comprehend Mesopotamia, Egypt, Central Asia and India.

The main gap in the picture was still represented by the Iranian Plateau. In 1967-68 took place the first field seasons of Tepe Yahya and Shahr-i Sokhta, which had the effect, since their very beginning, to deeply change the face of the protohistory of Southwestern Asia (Lamberg-Karlovsky 1970; Tosi 1968). The extensive evidence of highly specialized steatite-working activities in the Yahya IV B levels (Lamberg-Karlovsky 1970: 34-82; Lamberg-Karlovsky and Tosi 1973: 33-34) the early recovery at Shahr-i Sokhta of a gem-cutter's hoard (Tosi 1969: 371-373), and, above all, the information gathered from the EWK-EWP activity areas for lapis lazuli, carnelian and turquoise bead-making (Tosi and Piperno 1973; Lamberg-Karlovsky and Tosi 1973: 27; Tosi 1974; 1974a) threw light on the nature of the complex system of distribution and exchange linking Iran and its surrounding regions to lowland Mesopotamia, as well as on the processes of work specialization and social differentiation taking place within the social systems of the plateau centers.

The massive amount of data from prehistoric Sistan

allowed an extensive survey of the lapidary craft evidence in the town and in its suburban settlements, leading, as a basic achievement, to the detailed reconstruction of the manufacturing cycles of beads of different semiprecious stones: lapis lazuli (Tosi and Piperno 1973; Bulgarelli and Tosi 1977); turquoise (Tosi 1974; Bulgarelli 1981); chalcedony (Tosi 1973; Bulgarelli and Tosi 1977). It was possible, moreover, to study the tool-kits related to the manufacturing cycles, including a large number of sub-cylindrical drill-heads analogous to the ones found by Mackay at Chanhudaro, with the result of partially correcting some of his previous interpretations (Piperno 1973; 1981). Recently a microscopic analysis of a set of beads from Shahr-i Sokhta and Tepe Hissar of different materials further enhanced our knowledge of the beads' forming process (Gwinnet and Gorelik 1981).

The evidence from the settlement was complemented, in the Shahr-i Sokhta record, by the graveyard finds. Grave 77, the burial of a chalcedony and calcite bead-maker (Piperno 1976) is an ideological representation of the craftsman status in the contemporary society. Such a burial closely recalls analogous finds from the Royal Cemetery of Ur (Woolley 1934: 206-207). By comparing Grave 77 with Grave 12, being probably the burial of a lapis lazuli and turquoise cutter, Piperno (1976: 12) could hypothesize the existence of a well defined social differentiation between craftsmen processing imported materials to be traded on the international routes and those producing commodities whose raw materials were locally available, and were locally consumed.

The interest arisen by the Shahr-i Sokhta results is partially reflected in the later joint Tepe Hissar Project, and particularly in the surface survey of the craft activity areas of the site (Bulgarelli 1974; 1979). The work at Hissar revealed the presence of a highly specialized lithic complex, including large amounts of flint micro-drills and other types of tools and wasters functionally connected with lapis lazuli bead-making; this craft activity was apparently carried out across widespread sections of the town (Bulgarelli 1979: 42) according to a possible pattern of relatively decentralized small workshops. A second important development was the surface survey effected on the site of Shahdad (Salvatori and Vidale 1982), where a brief survey of the settlement area was enough to show the existence of striking surface pavements of metal smelting wasters and chalcedony bead-making debitage and tools. I remember surfaces littered with thousands of drills and carnelian disc-bead misproducts, suggesting the presence of true "bead factories".

The subsequent cessation of field activity in Iran in 1978 prevented us from testing many important working hypotheses, so furthering the development of our methodological propositions.

We may state that, by the end of the seventies, the body of information and experience so acquired had

given rise to a wide set of models concerning the structural logic of craft production, its material representation and its quantitative evaluation through the archaeological record (Tosi 1984; cf. Vidale 1983). This experimental theoretical framework, finalized to the analysis of the degree of control exerted by the elites of the centers over the craft production sphere during the evolution of the protourban structures, required obviously large-scale contexts of observation. The surface approach, allowing a comparatively rapid processing of large sections of the site, and being relatively inexpensive and non-destructive, appeared to be the most suitable tool of data recording and analysis. Its testing in the eastern Iranian sites, where wind deflation is the main post-depositional variable, investing the surface formations a sub-primary relationship with the original archaeological deposit, had been fairly satisfactory.

These introductory remarks had the purpose of illustrating the premises underlying our new phase of work in Sind. Following earlier field observations by M. Jansen and M. Tosi at Moenjodaro in 1980-81, the Surface Evaluation Program (SEP), jointly carried out by the RWTH-IsMEO team, took place in 1982, with a first objective to survey and record the craft activity evidence directly available on the surface of the archaeological compound as a whole, and with the ultimate, ambitious goal to spread light on the structure of the craft production originally operating through the system (Bondioli et al. 1984: 13-14).

The first two seasons of field research at Moenjodaro were obviously far from being exhaustive enough to allow any reliable conclusion. But the pattern emerging from the preliminary maps seems to present some significant divergences from the eastern Iranian sites. The large workshops and craftsmen quarters of Shahdad seem to be replaced by a scattered network of small productive cells, whose average dimensions would conform to the expected size of a small working floor or to the space occupied by one-two rooms of a normal Harappan house, and exhibiting a strongly discontinuous pattern of relative density of indicators (Pracchia et al. 1985). Such a model would appear to apply to semiprecious stone-working as well. To ascertain whether these possible divergences should be ascribed to an inner difference in the structure of the production system, or to different or alternatives post-depositional phenomenologies will be a necessary step in the development of the surface research at Moenjodaro.

In starting our work, it was decided to effect an intensive/extensive effort on surface recording and interpretation in the so called "Moneer South East Area" (hereafter MNSE Area) (Bondioli et al. 1984: 24-26; Pracchia et al. 1985). As stated on other occasions, the site was selected because of the high degree of concentration of artefacts and the size of the relative area of distribution, allowing the possibil-

ity of extending the technological analysis of the cycles as well as of testing the feasibility of the locational approach within the limited context of a single craft activity area. The present paper deals with a specific aspect of the MNSE Area evidence, i.e. the semiprecious stone-working record, as a further small step in the study of the town's system of craft production. Like a previous paper on the MNSE saggars (Halim and Vidale 1984) this contribution is to be conceived as a part of the preliminary presentation of the field activity carried on in 1983-1984. The analysis is centered on the composition of the MNSE surface assemblage, on the functional relationship existing among the different types of indicators and on the reconstruction of the processual aspect of the manufacturing cycles, against the wider background of the body of data on semiprecious stone-working so far available at Moenjodaro.

## 1.2. Evidence from Earlier Excavations

*"A few unfinished beads were found during the excavations at Mohenjo-daro. Their number was so small, however, as to suggest that though bead-making was a craft practised in that city it was not carried on to any great extent, unless it were in parts of the city that have not yet been explored."* (Mackay 1937: 1).

With this statement Mackay summarized the evidence gathered in the previous large-scale excavations. The Marshall report contains some sporadic references to agate unfinished beads coming from sections DK and SD (Marshall 1931: 144, 526). The inventory of the artefacts attesting semiprecious stone-working within the town's compound is not much longer: it includes two possibly unfinished agate "burnishers" (*ibidem*: 585), a single unfinished semiprecious stone marble (*ibidem*: 553), some "rough nodules" of amethyst (*ibidem*: 526) and some pieces of crystal from L Area (*ibidem*: 170), and a single unfinished chert weight (*ibidem*: 221).

The high standards of Harappan stone-working were first revealed by the spectacular find of the jewellery hoards recovered in DK Area, Trench E and HR Area (*ibidem*: 519-523). These discoveries offered an occasion to carefully examine the stones represented in the necklaces (*ibidem*: 525-526; 534-548). Chalcedony, with its great variability, appeared to be the preferred material (*ibidem*: 509, 525-526). Much attention was deserved to the skill needed by the artisan to exploit the natural banding of the agate geoids, controlling the orientation of the inner micro-layers in relation to the central axis of the bead (*ibidem*: 537). The report, moreover, mentions the artificial treatment of carnelian to improve its red colour (*ibidem*: 509), to decorate the bead with white drawings, as well as a possible technique to produce an artificial black stone (*ibidem*: 526). Discussion on bead-making technology is limited to the description of a sequence skeleton partitioned in four stages: rough shaping by chipping, flaking,

smoothing and boring (*ibidem*: 526). In a separate section of the report is outlined the reconstruction of the manufacturing cycle of stone marbles (*ibidem*: 533). More attention is paid to the long barrel-cylinder beads, and especially to the constraints of the drilling process (*ibidem*: 511, 520), in which, according to Mackay's early interpretations, a copper drill was possibly operated with a lathe, using emery as an abrasive (*ibidem*: 520).

The 1938 report offered to Mackay the opportunity to describe in greater detail a wide range of materials, tools and techniques. The author provides an accurate description on 10 unfinished stone beads (Mackay 1938: 501-502; see *Tab. 1*) with new information on the bead's forming and drilling processes. The reconstruction presented in the previous report is here both confirmed and enlarged upon. He is also suggesting the employment of "grooved" stones in the smoothing phases, although in the published "anvils", "whetstones" and "querns" we do not find any description or illustration of such a type of tool (Mackay 1938: 406-407). In several points of the report it is hypothesized the use of emery or silica abrasives: in smoothing the blanks (*ibidem*: 501, 502) or to shape the composite beads (*ibidem*: 504); in smoothing the hole of the carnelian long barrel-cylinder beads (*ibidem*: 662); and, confirming the old interpretation, with copper drills to perforate the beads (*ibidem*: 502). In spite of the frequent references to the employment of tubular drills in stone-working

(*ibidem*: 320, 323, 397, 399, 402, 411-412, 597) and the publication of two copper drills (*ibidem*: 475; Pl. CXXXI, 6, pl. CXXXII, 10) review of bead drilling technology does not go beyond the previously quoted statement. It is taken into account the possibility that relatively hard stones, notwithstanding the great technical problems, could have been cut with metal saws (*ibidem*: 583). The manufacture of the cube-shaped chert weights, furthermore, is briefly described (*ibidem*: 401).

Lastly, we can add to this scarce inventory of references the following quotation:

*"The discovery of a good number of beads, 16 small weights, a pair of small copper scale-pans together with a fulcrum rod made in a room directly accessible from the lane suggests that this was a lapidary's shop"* (Government of India 1936-37: 41).

The site to which the quotation refers is the DK-I or Moneer site (see also Government of India 1930-34: 51, 72; Dales 1982; Jansen 1984). Nothing more is known about this assemblage, except that the buildings had been excavated only to the upper levels (Government of India 1936-37: 41). The existence of a possible lapidary's shop in this section of the site would match with the evidence of large amounts of steatite wasters on the top of the western dump of the Moneer excavations (J. M. Kenoyer, personal communication, incorporated in Vidale, this volume) suggesting that part of the excavated structures (assuming that "shops" might have been located in proximity of working areas)

**Tab. 1: 10 unfinished stone beads published in the 1938 report**

Field No.	Pl.	Location	Material	State
DK 7692	CXI, 6	7, I, 5; -18,2	light brown agate splashed with white	roughly rubbed into shape, unbored
DK 5085	CXI, 41	3, I, 5; -14,9	black jasper with prominent veins	smoothed, unpolished unbored
DK 5365	CXI, 48	1, IV, 63; -13,7	light gray agate with milky bands and veins	smoothed in the middle portion; ends flaked, untouched; unbored
DK 2824	CXXXIV, 13	Surface	drab-coloured agate veined with white	smoothed, partially polished, unbored
DK 10413	CXXXVI, 7	6A, 41; -5,5	brown and white agate	smoothed, partially polished, unbored
DK 12450	CXXXVI, 8	6A, 41; -9,7	dark-gray agate	smoothed, unbored; ends painted
DK 12757	CXXXVI, 20	9A, VIII, 56; -9,4	dark green agate banded with red and black	roughly rubbed, unbored, possibly artificially coloured
DK 11135	CXXXVI, 28	Central Str., -6,8	white agate veined with brown and gray	smoothed, unpolished; partially drilled at one end
DK 11342	CXXXVI, 37	23, II, 13; -7,5	agate, irregularly banded and veined with brown on a white ground	smoothed, unbored
DK 11316	CXXXVIII, 14	8A, 38; -4,3	chocolate-coloured agate with white ends	smoothed, drilled at one end; partially drilled at the other

could have been involved in craft production. Doubtless, one is tempted to hypothesize a more or less direct connection between the early excavations finds and the recently recorded surface evidence.

After the excavation of the Chanhudaro "factories" a greater part of the obscure points of Mackay's technological reconstruction were solved. The raw material, particularly the plentiful carnelian nodules, are exhaustively described, as the preliminary chipping they underwent to allow the inspection of the inner structure (Mackay 1937: 3). The evidence suggesting thermal treatment of the material to intensify its red hue is considered (Mackay 1937: 3; 1943: 214). It was ascertained that carnelian was then turned into slips and rods by cutting the nodules with metal wires or saws operated with abrasives (Mackay 1937: 4; 1943: 211), a very advanced technique, eliminating the need of a wasteful chipping and leaving the task of forming the rough-outs to a simpler, more regular flaking. The subsequent shaping phases were related to the employment of "bead-stones" (Mackay 1937: 5; 1943: 214), i.e. sandstone blocks bearing grooves with a strong inner polish. Being the grooved stones gritty enough, the need to employ abrasives was denied (Mackay 1937: 5). A third, basic contribution was the extensive review of the drilling apparatus. In the Chanhudaro assemblages were recognized some "ribbon flakes terminating in a point" (Mackay 1937: 5) which could have been used to produce on the blanks the first guide-depression for the subsequent drilling. The same chert borers were used to perforate carnelian disc-beads (Mackay 1937: 9; 1943: 210-211). The disc-bead rough-outs were obtained by sections of the longer slips prepared for elongated beads (Mackay 1937: 9; cf. also Gwinnet and Gorelik 1981: 14). It may also be observed that, in dealing with the perforation of carnelian disc-beads, Mackay described a splintering rather than drilling technique, an intuition recently confirmed by the detailed study of a small atelier at Larsa in Mesopotamia (Chevalier et al. 1982). Finally, in the last reconstructions the copper drills are replaced by the newly identified sub-cylindrical stone drills (Mackay 1937: 6; 1943: 211-212), so completing the outline of the technological sequence. The final polishing process was destined to remain elusive in the archaeological reconstructions (Mackay 1937: 9; 1943: 211).

One of the results of the preliminary phases of the surface survey at Moenjodaro has been to demonstrate that the technological know-how of the Chanhudaro craftsmen was fully shared by the lapidaries of Moenjodaro. The whole range of techniques studied by Mackay seems to be attested by the relative set of indicators, from the grooved stones to the stone slips cut with metal saws and the sub-cylindrical stone drills. But this technological homogeneity has to be viewed on the background of a set of dichotomic differences between the nature of the two sites. The striking concentrations of indicators found in the small

site of Chanhudaro have not yet been found in the major center, in which, as far as we may now observe, lapidary craft was carried out in accordance with a rather disaggregated organizational pattern.

### 1.3. Distribution of the Semiprecious Stone-Working Evidence Across Moenjodaro

Before discussing the apparent distribution of semiprecious stone-working across the site, we have to emphasize that the observable record is produced not only by an abstract ancient cultural pattern, but also by the intervention of a wide, heterogeneous series of external variables that may be collated under the general definition of post-depositional factors. Leaving aside the uniform work of dislocation of atmospheric agents, one of the most important factors may be identified in the dynamic of recollection and reworking of discarded stones in the framework of the production cycle itself. At Cambay, the Gujarati town still famous for its bead-making factories (Arkell 1936; Trivedi 1964; Possehl 1981) smaller and lower-quality stones are progressively recollected from the abandoned heaps till the market can absorb less valuable products or simply requires smaller beads (J. M. Kenoyer, personal communication). To this form of reworking, accomplished through further physical reduction, must be added possible forms of recycling through the intervention of more complex physico-chemical transformations, like in the case of the silica material ground into powder for faience-related industries (Vidale in this volume). Secondly, the representation of the relative incidence of the different stone varieties in the archaeological record is a direct function of the stones' resistance to weathering and decay (Bondioli et al. 1984: 19-21). Silica stones often bear strongly altered, whitish surfaces, but they appear to be successfully attacked by salt only in presence of pre-existing heat-caused crackings. Softer stones, in first place steatite and limestone, are definitely much more perishable; serpentine appears to be rather resistant in spite of its moderate hardness, while turquoise, very rare at Moenjodaro, is notoriously prey to damage from oxidation. Finally, surface distributions may have been deeply affected by other cultural noise sources such as the practice, apparently still very common in Sind, of collecting chalcedony-agate fragments and objects to turn them into "akik", considered a very healthy and precious medicine (Sher and Vidale 1985).

The map reproduced in Fig. 1 summarizes the most relevant evidence provided by the excavation reports and gathered with the first two seasons of the SEP up to March 1984. As one could have observed in reviewing the existing literature, the available information is absolutely scarce and episodic. For what concerns the surface survey, the present estimates must be considered only preliminary. Activity Area (AA) 40 is by far the most substantial concentration so far discovered at

Moenjodaro (Bondioli et al. 1984: 24; Pracchia et al. 1985); it is followed by the small AA 1 and 3, presenting semiprecious stone lumps — flakes — bead blanks associations. We expect that similar small AA shall be much more numerous at the end of our research. AA 1 and 3 were detected by a very close inspection, observing the surface from a 20-40 cm. distance, after a series of areas had been randomly selected at the beginning of the survey.

Symbols *b*, *c*, *d* in Fig. 1 represent respectively the surface find of minor concentrations with bead blanks, large unexhausted of defective chalcedony blocks (see Figs. 13-14) and minor clusters with semiprecious stone flakes and (defective) rough-outs. The resulting picture leads us, again, to a specific dimension of the disaggregated model of craft organization we have previously mentioned. Lapidary craft would have been practised in different sections of the town including the Citadel, a pattern consistent with that observed for deeply different specializations, such as shell working (Kenoyer 1984: 105-108) or stoneware making (Halim and Vidale 1984: Fig. 8). On the other hand, we repeat, it is still quite possible that a large "bead factory" would be revealed either by an intensification/extension of the survey or by further erosion of the site surface.

There is an independent research approach which could provide substantial light in the subject: the systematic effort by the RWTH team to relocate the 38.000 entries in the original excavation registers into the architectural context (Ardeleanu-Jansen et al. 1983)<sup>1</sup>. Once this task has been accomplished, we should have at our disposal a complex diachronical framework of data to be attemptively interpreted. A brief examination of the materials kept in the Moenjodaro Museum and its Reserve Collection clearly reveals that the recovery of semiprecious stone rough-outs, blocks, blanks and debitage (Figs. 2, 3) had to be not all infrequent across the excavated quarters.

## 2.1. Surface Analysis in MNSE Area, 1982-83

The surface recording of the site, enclosed in a rectangular area 60 x 45 m., with a total extension of 2700 m<sup>2</sup>, was accomplished by the end of the 1983 season. The methodology of data collection, involving centimetric localization of artefacts and use of suspended platforms for non-destructive observation of the surface, has been discussed in a previous paper (Bondioli et al. 1984: 21-23). The surveyed area (Fig. 4), delimited by 2820-80 (Long.) and 1235-80 (Lat.) coordinates of the grid system, encloses to the west a portion of the level plateau of the lower town and, towards east, a larger slope section, cut by a series of deep, winding valleys running from west to east. The valleys alternate with series of promontories, corresponding to compact aggregates of structures deviating erosion along the edges, usually formed by fired brick walls

more or less closely orientated according the cardinal points. The main geomorphological feature in the site is the large promontory occupying a central position in Fig. 4. It probably marks a sub-rectangular or trapezoidal structure apparently covering an area of 15 x 25 m. ca., and forms at middle slope an irregular terrace strongly attacked by erosion on four sides. The two west-east oriented valleys bordering the promontory at north and south have particularly steep gradients in correspondence of the contact zone between the upper section of the slope and the terrace; progressive erosion will isolate the promontory, in the near future, as a low, separate hummock. Outcropping of semiprecious stone-working indicators in MNSE Area results closely associated to such a feature; their distribution on surface shows two irregular crescent-shaped clusters, at west and east of the promontory. The dense western concentration marks the zone more intensively attacked by erosion between the upper slope and the terrace edge. The eastern cluster, characterized by an inferior density, is uniformly exposed along the gentle gradient of the promontory facing the lane.

Different sources of information are currently being taken into account to come closer to a definition of the genesis of the surface clusters of indicators, including aerial photography and mapping of the visible structures, as well as sedimento-archaeological mapping of the surface formations variability, carried out by C. Balista and G. Leonardi. As a complementary analytical step we effected a series of experiments of sub-surface inspection, stripping the topmost sediments by forced air to expose the erosive interface. The most important stripping test, involving an area of 15 x 0.5 m., crossed the western crescent-shaped concentration, allowing the recovery of substantial information on the depositional context. These topics shall be discussed in a separate forthcoming report. Forced air cleaning has the effect to expose sedimentological micro-features in satisfactory conditions of chromatic contrast without direct mechanical alteration of their delicate stratigraphic pattern. It was thus possible to gather some evidence suggesting, at this preliminary stage of research, a secondary context of deposition of the lithics, which could have been progressively accumulated along the slopes after their systematic removal from their primary setting on the working floors. This hypothesis will be tested against the evidence provided by the other analytical procedures.

## 2.2. Composition of the MNSE Area Lithic Assemblage

During the systematic recording of the site we found a total amount of 3263 lithic artefacts. Being the surface of an archaeological site the final output of a potentially unlimited set of quite different processes, if we consider that our assemblage is substantially produced by a phenomenology unitary in space and time, we also

expect that it unavoidably includes a certain amount of items produced or discarded in the frame of other synchronical phases of human activity. In this perspective, the present preliminary estimates are biased by the intervention of a certain degree of noise the extent of which shall be evaluated after the locational analyses and the functional study of the tool-kits will be completed.

The artefacts were recorded on the field, and directly entered in an inventory. After the preliminary examination in the SEP laboratories, the materials were stored in the Exploration Branch collections of the Department of Archaeology and Museums of Pakistan, Karachi, where they were classified and codified. Figs. 5 and 6 show the nomenclature of the identified minerals and rocks according to Dana's system (Hurlbut 1959).

The diagram in Fig. 7 represents the relative incidence in the assemblage of all the identified rocks and minerals, while in Fig. 8 the semiprecious stones involved in the manufacturing cycles as processed materials are considered without the other classes. In both the cases, the percentages are calculated by number of recovered indicators.

Chert finds (Fig. 7: about 63% of the total assemblage) amount to 2100 units ca., thus representing the most important class (Fig. 9). The chert recovered in MNSE Area does not differ from the chert so widespread in the other sections of the compound, and it conforms to the basic features described by Kenoyer (1984a: 118-119) in his study of the UPM lithics. A small part of the chert is banded, and few fragments and rejected rough-outs (Fig. 71) should be considered as related to the manufacture of cube-shaped weights and micro-weights (cf. Mackay 1938: 401). The chert assemblage is currently studied by G. M. Bulgarelli, and her work will more specifically evaluate the evidence of functional interrelationships between lithic tool manufacture and their employment in semiprecious stone-working (for an extensive review of the connections between lithic tools and lapis lazuli working at Tepe Hissar see Bulgarelli 1979). We may preliminarily observe that not less than 43% of the chert complex is formed by broken unretouched bladelets bearing no macroscopic evidence of wear, nor extensive edge-damage. If we add to this value the substantial number of drills obtained from chert bladelets (about 240, i.e. 11% ca.) we would have a percentage of 54-55% of the chert items possibly connected with drill-making and employment.

The class "metamorphic rocks" (Fig. 7: about 5%) is almost entirely formed by quartzite flakes, very often in form of small splinters bearing surfaces polished by grinding and detached from quartzite quern stones (Fig. 10). These tools are ubiquitous finds on the surface of Moenjodaro, and should have been widely used in household activities; they were also utilized as bead-making tools, and some recovered specimens show to

have been reutilized with this function after the breakage (Figs. 46-48). The assemblage perhaps contains different types of quartzite, and possibly some varieties of sedimentary quartzite or quartz-arenite, but it is generally difficult to recognize metamorphic quartzite from sedimentary one (Dietrich and Skinner 1979: 196).

A very small amount of flakes and two bead blanks have been identified as metamorphized carbonate rocks and defined as "marble". Metamorphic stones like breccia, conglomerate and marble were commonly used at Moenjodaro for the production of small items such as gamesmen (Marshall 1931: 557, Mackay 1938: 77, 576, 578); balls (Marshall 1931: 553) and beads (Mackay 1938: 498). As a matter of fact, as in the case of quartzite flakes, it is not always immediate to distinguish stones of this class from sedimentary carbonate rocks of more common occurrence, particularly when the fragments are very small.

The assemblage, moreover, comprehends a minor percentage of sedimentary rocks (Fig. 7: 3%) part of which is formed by limestone or limestone-like flakes. An unfinished bead (Fig. 52, c) demonstrates the use of limestone in bead-making in MNSE Area. According to the reports, limestone beads were very popular at Moenjodaro (Marshall 1931: 148, 512, 513; Mackay 1938: 449). Besides beads, the list of the limestone objects includes a striking variety of products: cones (Mackay 1938: 407-408), marbles (*ibidem*: 567), dice (*ibidem*: 560), weights (*ibidem*: 320), seals (*ibidem*: 348), statues and figurines (*ibidem*: 257, 284, 298), mace-heads (*ibidem*: 397-399), jar-stands (*ibidem*: 207, 213, 413), "pedestals" (*ibidem*: 412, 413), ring-stones (*ibidem*: 595-598), grinders and rubbers (*ibidem*: 394, 407), vessels (*ibidem*: 320). The various possible context of utilization of limestone in the form of finished products, including its possible employment for tools, a relative degree of dishomogeneity in the recovered fragments, their small size and strong weathering suggested to rule out from the diagram of Fig. 8 the limestone flakes. The sedimentary rocks include also a group of sandstone artefacts; the employment of sandstone in semiprecious stone-working is demonstrated by the recovery of a large block with bead-smoothing traces (Figs. 49-51), but polishers and shapeless flakes are also on record.

The sub-cylindrical drill-heads were, without exception, obtained from a very distinctive type of chert (Figs. 56-59), which in the literature is sometimes called "phtanite" (see, among others, Jarrige and Tosi 1981: 135). In the 1937 report it is stated that this type of chert contains magnetite (Mackay 1937: 6); its visual inspection suggests the presence of iron-manganese oxides. The small incidence of this very distinctive material in the assemblage (little more than 1%) may refer to its extremely specialized utilization.

The igneous rock group (about 0.4%) is represented by a handful of basalt flakes, sometimes bearing highly polished surfaces, possibly indicating the use of

pounders and pestles.

The other classes represented in the diagram of Fig. 7 are the mineral series utilized as semiprecious stones; in the diagram of Fig. 8 they have been isolated to evaluate their relative importance. The chalcedony group of stones forms the greatest majority of the semiprecious stones recovered on the surface of the site (Fig. 8: 72%), the histograms of Figs. 16-18 illustrate the internal variability of this group according to the identified structural/chromatic varieties. As observed by Tosi (1980: 448) such varieties "can be better classified from a commercial than a mineralogical point of view, as this extreme differentiation contrasts with an absolute uniformity of physical properties. . .". To a certain extent, the names given to chalcedony varieties by a given socio-cultural context depend more upon a set of historically determined constraints than on a system of physical attributes, and this situation may explain the degree of confusion existing among the different adopted classifications and the overlapping character of some typological terms. According to Francis (1982: 2) another source of confusion is to be identified in the extremely wide range of physical and chemical treatments (very often involving pyrotechnological processes) by which it is possible to produce artificially coloured varieties. The nomenclature here adopted (which is simply aimed at describing the variability of the discussed assemblage) results from the comparison between the typology proposed by Bulgarelli and Tosi (1977; see also Tosi 1980) and some terms commonly used in the literature on the Indian beads (see, among others, Francis 1982: 1-2).

Chalcedony is found at Moenjodaro in two different basic varieties: fragments of small, ovoidal nodules ranging 2-10 cm. in diameter (Figs. 11, 12) and radial fragments of larger blocks, bearing, as a rule, wide portions of cortex, and formed, for a significant part of their volume, by the long, irregular quartz crystals contained in the inner cavity (Figs. 13, 14). In both cases the concentric banding characterizing geoid formation is easily recognizable. The first group is by far the most common: the stones belonging to it always present a highly polished cortex, denouncing the secondary alluvial context of extraction of the pebbles. The larger fragments of the second group, on the contrary, have rough, irregular cortical surfaces still bearing traces of the softer calcareous gangue indicating the direct extraction of the blocks, probably in the form of thick veins with an inner concentric core from the mother rock. Furthermore, the two groups appear to be distinguished by their chromatic range, restricted to whitish-bluish shadows for the larger blocks, while smaller pebbles often exhibit brownish, olive or reddish hues. In the MNSE Area we have recovered so far only specimens belonging to this latter group, but, on the other hand, it is not to be excluded that part of the minute flake debitage

(Fig. 15) was detached from larger blocks.

Chalcedony geoids are considered fruit of the deposition of silica gel trapped in gas pockets or bubbles present in lavic formations (Wadia 1983: 119; Tosi 1980: 448; Francis 1982: 2). The distinctive inner banding of chalcedony and, in particular, of agate geoids has been ascribed to the dynamics of discontinuous precipitations of metal oxides captured from the cavity's walls in concentric, locally saturated zones of the colloid filling, in accordance with "Leisegang rings" simulation model (Overbeek 1978: 855-856).

Such formation dynamics are directly responsible for a series of features which are of outstanding relevance in the manufacturing sequences, particularly for the fibrous, coarsely crystalline banded varieties of chalcedony so frequent in the MNSE Area assemblage, in first place carnelian-agate.

Carnelian-agate is the name adopted here to define all the specimens characterized by a yellowish-red hue and a marked internal concentric banding of translucent or white stripes. This term has been preferred to the term "carnelionyx" which (besides being suggestive of strange mythological creatures such as chimeras and manticores) would imply a more regular pattern of banding (Francis 1979: 21, 79). Carnelian-agate represents 63.5% of the total group of banded varieties (Fig. 18, 1) and carnelian forms 44% of the monochrome ones (Fig. 17, 1). The two varieties would thus account for no less than 53.8% of the whole semiprecious stone group (Fig. 16), clearly characterizing the bead-making industry of MNSE Area as oriented towards red translucent varieties, while at Shahr-i Sokhta sardonyx is the most popular banded chalcedony (M. Tosi, personal communication). It is useful to recall that any distinction between monochrome and banded red varieties is based on quantitative more than qualitative parameters: also some of the best carnelian beads show, on closer inspection, a pattern of concentric transparent banding. The term "carnelian" is here intended to define any particularly good variety of red translucent chalcedony, whose translucent or transparent banding does not contrast with its basic shadow. Another possible source of error in this distinction is that, in the case of agates with large bands, small flakes, representing the greatest majority of the artefacts on record, could be classified with the monochrome group.

A series of translucent monochrome specimens has been classified as "whitish chalcedony" and "yellowish chalcedony", in spite of a similar difficulty in drawing a clear-cut line between the two shadows; the same observation may be true also for the less common "grayish chalcedony". The three light-coloured varieties, as a whole comprise, about 47% of the monochrome varieties (Fig. 17, 2-4) and 23% of the total chalcedony (Fig. 16). Other monochrome varieties on record are sard and praze, the brown and light-apple green shadows of chalcedony, but their incidence would

appear rather unimportant (Fig. 16). "Pyroclastic chalcedony" flakes, always in Fig. 16, for a small group to be discussed in paragraph 3.2.

Two varieties of agate recovered in the site were called respectively "whitish-grayish agate, white-banded" and sardonyx (6.8% and 6.3% in Fig. 16), this latter being brown-coloured chalcedony with concentric whitish stripes, a class partially shading into the red varieties. Lastly, we may mention the recovery in a separate subsurface test at the site of some flakes of moss-agate, presenting the very distinctive green dendritic inclusions.

With the term "serpentine" we define a light-apple green translucent stone characterized by a waxy luster and 4-4.5 hardness on the Mohs scale. This stone (Fig. 19) was defined in other occasions as "jadeite" (Bondioli et al. 1984: 24), but in the light of the described features this is probably incorrect, and a proper physical determination is needed. This attractive material forms 2.6% of the whole assemblage (Fig. 7), and approximately 10% of the semiprecious stones group (Fig. 8), being the second stone of importance after the chalcedony group; it was worked into beads and small objects among which we could ascertain the presence of truncated-cone shaped gamesmen (Fig. 35, i).

Jasper, present with flakes, rough-outs and bead blanks (Figs. 20, 21) accounts for about 2% of the whole assemblage (together with the group heliothrope-plasma: Fig. 7) and for 7.5% of the semiprecious stones group (Fig. 8). The recovered jasper debitage exhibits a striking chromatic variability, a circumstance recalling analogous features in the jasper beads found in the excavations (Marshall 1931: 545; Mackay 1938: 499). According to Dana's manual, heliothrope or bloodstone would be a kind of green chalcedony containing small spots of red jasper (Hurlbut 1959: 482). In Fig. 8 the group "bloodstone<sup>2</sup> plasma", accounting for 5.5% of the semiprecious stones, is a rather dishomogenous group of greenish, more or less translucent specimens. Given the difficulty in classifying correctly the very small flakes forming a large part of the debitage, all the green varieties (with the exception of some particularly recognizable fragments of praze) were grouped under this term. Fragments bearing the red spotting of heliothrope are rarely found, but the employment of this stone in bead-making is clearly attested by the recovery of a couple of blanks (Figs. 40, f; 41, c), confirming the popularity of this stone at Moenjodaro (Marshall 1931: 544).

Rock crystal (Fig. 22), accounting 3% in Fig. 8, is represented in the assemblage by a series of small flakes that, sometimes, could be confused with the elongated quartz crystals produced by the breaking of the geoid's inner cavity (Fig. 23). This could have slightly biased the representation of rock crystal incidence across the assemblage. Rock crystal beads, although rather rare, may be found on the surface of Moenjodaro and some-

times occur in the excavation find lists (Marshall 1931: 512; Mackay 1938: 498-499). A single rough-out could possibly suggest the presence of crystal bead-making activities of secondary importance (Fig. 38, f). Amethyst, whose employment in bead-making was not uncommon (Marshall 1931: 526) is represented in the site by a single flake.

Turquoise would be attested in the MNSE Area by a single bead blank (Figs. 41, b; 45). The identification, anyhow, is still rather uncertain; in case of confirmation, the find could be of particular interest, because the use of turquoise at Moenjodaro was apparently exceptional (Marshall 1931: 525). Lapis lazuli is present with one small chip and a single tiny bead blank (Fig. 52, i). Like turquoise this stone would seem to be definitely rare, both in the find lists and on the surface of the town (cf. Marshall 1931: 528; Mackay 1938: 500). If the scarcity of lapis lazuli were to be ascribed to a low consideration of the blue stone in the Harappan world, or to some kind of ideological attitude rejecting it, such a picture would be consistent with recent reviews of archaeological and literary sources on the position of the stone in protohistoric India (Chakrabarti 1978; Buddrus 1980).

Lapis lazuli and turquoise in Fig. 8 are grouped with other materials, such as some marble or limestone flakes and bead blanks and sundry unclassified flakes. The total incidence of this dishomogeneous group in the semiprecious stones assemblages is 1.2%.

We may now summarize the evidence we have reviewed: the MNSE Area lithic assemblage is mainly composed by chert remains, a significant part of which was probably connected with making of drill-heads; "phtanite" sub-cylindrical drill-heads were certainly manufactured and utilized in the area; a relatively large set of indicators in various materials, mainly rocks, may have been produced by the employment of hammering, flaking, grinding, polishing tools<sup>3</sup>; among the worked semiprecious stones chalcedony largely prevails, and, within the chalcedony group, the red varieties are most substantially attested, preceding other monochrome or banded stones; besides chalcedony, in order of importance, we meet serpentine, the jasper-heliothrope-plasma series and rock crystal; other very distinctive materials such as amethyst, moss-agate, lapis lazuli and, possibly, turquoise, although present, are definitely very rare.

### 2.3. A Sub-surface Test in MNSE Area

At the end of the 1984 campaign a small-scale specific test was monitored to investigate the sub-surface composition of the northern cluster of lithics (Fig. 4), to compare it with the more general composition of the surface complex.

For the test an area of 1 m<sup>2</sup> was selected at the western edge of the concentration. In this area the topmost surface covering, formed by loose, deeply

altered silt of a relatively dark shade, was removed down to the erosion interface with the layer(s) generating the surface spread of lithic remains. The removed deposit was then hand-sieved in dry conditions by a 1 mm. sieve, yielding very small chips as well.

This histogram in *Fig. 24* gives the absolute weight in grams of the various lithological classes once chert is left aside. The overall composition of this second assemblage may be traced back to the previously described pattern, with an absolute predominance of chalcedony over the other classes. We preliminarily assumed that the weight of the lithics, in absence of large anomalies like nodules of raw materials or heavy tools, retain a significant correlation with their number. Thus it was possible to compare the diagram in *Fig. 24* with *Fig. 7*: the higher incidence of stones such as phtanite, sedimentary and metamorphic rocks, will be observed balanced by an absolute decrease of semiprecious stones such as serpentine, jasper and the heliothre-plasma group. Once the evaluation is limited to the semiprecious stones (i.e., after the elimination of phtanite, sedimentary and metamorphic rocks), we obtain the diagram visible in *Fig. 25*, to be compared with *Fig. 8*. In spite of a substantial increase in the chalcedony percentage, the overall pattern revealed by the sub-surface collection would appear rather consistent with that of the surface, bearing serpentine after chalcedony, followed by heliothre-plasma and jasper (whose relative importance would appear inversely represented), rock crystal and others.

Wishing to avoid any premature inference, we may simply state that the general composition of the MNSE assemblage of semiprecious stones would appear to be substantially reflected in the composition of one of its local clusters, or, in a slightly different perspective, that the surface assemblage may be considered as the final output of a process still locally operating according to high standards of uniformity. On the other hand, divergences such as the greater incidence of phtanite in the sub-surface complex (*Fig. 24*) may suggest the presence of smaller, localized concentrations of wasters of the same stone, produced and disposed in the frame of specific operations.

The following paragraphs of the paper are concerned with the processual aspect of the assemblage, i.e. with the functional interpretation of the different classes of indicators of lapidary craft activities and their sequential arrangement.

### 3.1. Description of a Case of Multi-dimensional Variability

One of the most interesting features of the MNSE Area assemblage of semiprecious stone-working lies in its composite nature. Although the available evidence is very far from providing a systematic record of the whole set of performed cycles, we may envisage a situation in which to the "linear" variability of the indicators produced by a single cycle (e.g. a type of ornament

produced by a single stone variety) we should add the variability resulting from the cooccurrence of more cycles (e.g. various types of objects from the same stone: cfr. *Fig. 35*). The picture is further complicated by the cooccurrence of semiprecious stone types with quite different petrological features and calling, consequently, for the adoption of correspondingly wide range of manufacturing techniques. As a matter of fact, the main difficulty of the present report was to organize and describe this multi-dimensional variability in a single systematic framework.

To some extent, this goal was pursued by biasing the discussion in an analogical direction, by organizing the diagram of *Fig. 26* mainly in accordance with the structure of bead-making cycles (which in any case determine the greatest majority of the indicators) and by leaving a separate description (paragraph 3.7.) to the other sequences on record.

The diagram of *Fig. 26* is subdivided in two superimposed horizontally-oriented sections; the upper one describes the various transformational sequences affecting the recovered stone varieties, while the lower one sets out to describe the relative artefactual evidence. A major emphasis in the diagram is placed upon the horizontal direction, representing the materials' trend to be transformed into finished products. In this perspective the upper section may be conceived as the "continuity" part of the diagram, while the lower one, on the contrary, contains the corresponding elements of "discontinuity". A basic concept behind the flow diagram is that the archaeological record exerts a kind of gravitational attraction towards the manufacturing sequences, breaking their continuum by subtracting in different moments fractions of matter in different stages of transformation (e.g. debitage, unfinished products). The archaeological reconstruction of the manufacturing cycle is compelled to re-trace the reverse path, i.e. to restore ideally the transformational continuum by reconnecting the surviving evidence of the chain — the different manufacturing stages, as attested by debitage and unfinished products, plus information provided by other classes of indicators such as facilities and tools — (Tosi 1984: 25).

It has been possible to recognize a common organizational skeleton shared by the various cycles attested in the assemblage: this is expressed in the succession of stages moving from left to right in the topmost part of the diagram. Such internal units of the sequences have here been defined and conceived as generically paratactic organizational units, according to the model followed, among others, by Feinman et al. (1981). The arrangement of such units within a hierarchical structure articulated in processes, operations and phases (Buson and Vidale 1983: 33-34) would depend upon a closer analysis of each cycle as well as on specific experimental simulations. We may state, anyhow, that this basic scheme would include at least three different processes: forming (from the separation

of the lump to the rounding of the blank), drilling and polishing. The greatest majority of the indicators in MNSE Area refers to internal operations of the forming process (Fig. 27). For the drilling process the residual evidence is formed by a good number of drills and some rare bead blanks broken in perforation, while the polishing process, so far, is totally unrepresented and has been included only to complete the trajectory of the production cycle. The firing process (see paragraph 3.2.) could have intervened in several moments of the sequence, according to a more elastic schedule.

From each stage of the sequence, in Fig. 26, departs a vertical column, leading, through the definition of the various techniques on record or, sometimes, expected for the various materials, to the corresponding stages of the processed stones, entering so the lower section of the diagram, e.g. the archaeological record in its material expression. One may observe that the artefactual evidence has been arranged according the three categories of *sequence execution*, *sequence suspension* and *sequence interruption*, with increasing levels of entropy from the upper one downwards, always according to the "gravitational" concept formerly expressed. These terms do not define classes of materials or types of artefactual evidence, but indicate behavioural trends of the indicators of a given processed material in relationship with the relative manufacturing cycle. An integrate conception of the artefacts' flow within the enlarged context of a social system has been provided by Schiffer (1972).

"Sequence execution" is substantially a highly abstract category; as the successful accomplishment of all the manufacturing stages leaves relatively scanty evidence, this category is present in the archaeological record to the extent of being progressively incorporated into the finished product.

"Sequence suspension" indicates a state of temporary arrest of the manufacturing sequence, expressed by fractions of matter which, although still suitable for processing, do not enter the transformational flow, or are extracted from it by loss or selection and left aside (as in the case, for example, of stored deposits of unworked material, of unexhausted lumps or cores, or, again, of semifinished products abandoned in the archaeological record). Tosi's Semifinished Products (SFP) and Stocked Unworn Products (SUP) classes of archaeological craft indicators (1984: 25), the quoted observation of Kenoyer on re-working of chalcedony nodules at Cambay, his note on the presence of hoards of unexhausted shell cores at Moenjodaro (1984: 106), strongly suggest that, far from being fruit of accidental phenomena, the extraction of amounts of matter and, consequently, the freezing of given value amounts from critical points of the manufacturing sequences resulting in "sequence suspension", was of outstanding importance in the Moenjodaro craft production system, and in the town's economy in general. Coming back to

Cambay, the widespread heaps of nodules visible along the streets and around the houses optimally exemplify a case of sequence suspension in which the presence of unworked material performs specific economic functions (e.g., scattered storing of material to be reinserted in the flow according to market vagaries; or, again, as we would be able to observe in Cambay, the heaps may function as testing benches for training apprentices). In this perspective, then, it is possible that not only storing, but also discarding, abandonment or loss (given the elusive nature of the boundaries among such categories) of exploitable material played an important part in the Harappan organization of labour as well.

"Sequence interruption" indicates a state in which the material is characterized by features forbidding its passage onto successive stages of transformation. Flake debitage, lumps too small to be converted into beads, beads broken in perforation are example of indicators necessarily falling into this category and condemned to be definitively discarded. If fractions of matter may move from sequence execution to suspension to later re-enter the transformational flow, once they enter the interruption sphere they become static elements of the archaeological environment, unless they could be recycled in form of silica powder — for the quartz series — in other manufacturing cycles or in segments of the same cycle (for example, in the form of abrasives).

This threefold distinction has no immediate classificatory value: while the case of a bead broken in perforation is not ambiguous, it would be difficult, in general, to state if a single, small chalcedony lump should be considered as an element of sequence interruption or suspension as, to a certain extent, the possibility of turning it into a bead would depend upon hardly measurable cultural standards. The utility of this viewpoint would rest in the perspective of integrating, on a large scale, the evaluation of craft production and goods circulation and consumption in a single energy/matter flow framework. The histogram of Fig. 27 shows the relative incidence of the main classes of craft indicators by stone varieties. Flake debitage forms the absolute majority of the assemblage; if we leave aside the doubtful evidence provided by a relatively large group of small rough-outs in chalcedony and jasper (also including fragmentary specimens) it appears that the greatest majority of the indicators recovered in the site belong to the "interruption" category, conforming to the dumping dynamics hypothesized in paragraph 2.1. for the assemblage after the surface stripping experiments.

The described framework offers us the possibility of tackling with the technological evidence gathered in MNSE Area in accordance with each stone type's manufacturing cycle, as well as according to the shared organizational skeleton expressed by the vertical columns of the sequence stage. It was decided to pursue this latter course, as the description by materials

would have had the effect of overstressing the already wide variability of the assemblage.

Description of the bead-making sequences has been articulated in the following six points: Thermal Treatment of Chalcedony; Lump Separation; Rough-out Making and Regularization; Rough-out Smoothing and Blank Rounding; Drilling and Polishing.

### 3.2. Thermal Treatment of Chalcedony

A particular problem arises from the probable intervention in the manufacturing sequence of chalcedony beads of thermal treatments, with the double goal of enhancing the nodules' suitability for forming operations and, all along the sequence, of increasing the red colour of carnelian. A complex of pyrotechnological techniques, ranging from sun-heating to true firing has been described for the Cambay manufactures (Trivedi 1964: 12-14; Possehl 1981: 41-42; Francis 1982: 5). In the light of the world-wide diffusion of thermal treatment techniques of stone processing and their probable great antiquity (Purdy 1982: 40-41) the assumption that Harappan craftsmen extensively produced heat-treated carnelian seems quite reasonable (see the previous quotation from Marshall's report in paragraph 1.2.; Sankalia 1970: 38). According to the excavator, the so-called "bead factory" of Lothal was furnished with a bead-kiln to fire chalcedony (Rao 1973: 70, 77, 103; 1979: 83-84, 118-120). The sequence of firing operations affecting monochrome and banded chalcedony in Fig. 26 is intended to stress the possible recurrent application of thermal treatment in various transformational stages. At Cambay it is possible to observe, besides sun-heating of the nodules, the firing of the same nodules in closed containers arranged in open pits, the re-heating of the formed rough-outs with the identical technique, as well as additional stages of re-heating in smaller movable infrastructures (Laveri's description quoted by Purdy (1982: 41) would apply to these latter stages). At Cambay the choice of applying, after chipping, further thermal treatments in other moments of the sequence would appear rather context-dependent; the cycle's structure would retain, from this viewpoint, an inner elasticity.

The MNSE Area assemblage includes a small group of flakes classified as "pyroclastic chalcedony", accounting for no more than 1.7% of the chalcedony varieties (Fig. 16). They generally present a whitish, opaque shadow, often dotted with localized splashes of red; on the larger specimens deep inner cracks produced by heating are visible. This evidence might indicate either accidental or intentional exposure to fire. It should be stressed, on the other hand, that part of the chalcedony could actually have been turned red in this way. From other sites of the compound we have been able to recover a collection of whitish, fire-cracked chalcedony blocklets characterized by squared shapes (Fig. 28); it is not clear, however, to what extent such

forms have to be ascribed to chipping or to natural breaking following accidental firing. Artefactual evidence of chalcedony thermal treatment at Moenjodaro, in spite of its very probable application, thus remains very doubtful.

### 3.3. Lump Separation<sup>1</sup>

"Lump" in this paper indicates the minimal fraction of stone necessary that can be reduced into a bead. From a geometrical viewpoint it may be conceived as the larger solid figure in the sequence enclosing the designed bead. "Lump separation" is therefore the operation needed to isolate the lump from a larger mass. This operation, obviously, was not necessary in the case of small natural lumps such as pebbles already endowed with the required dimensions (as in the case, possibly, of some of the fragmentary pebbles reproduced in Fig. 11). Far from being an undistinguished preparatory stage, lump separation requires high standards of skill, much care, and plays a fundamental role in all the subsequent stages. Failure to control a complex set of variables such as the bead's designed dimensions, the three-dimensional orientation of features like banding, fracture lines or other imperfections, result not only in the loss of the separate fraction but also in the irreversible damage of the whole mass. This latter, in pebble or block form, was probably inspected on several occasions (starting from extraction) before lump separation. The quality of the chalcedony pebbles and texture was checked by removing one or more cortical flakes (Fig. 12); a hoard of carnelian pebbles observed on the surface of the excavated area at Chanhudaro (Sher and Vidale 1985) exhibited the same traces.

The "Lump separation" column in Fig. 26 gives the different techniques observed or expected for the various materials; for chalcedony, we find breaking, splitting and sawing. (Oriented) breaking and (oriented) sawing are expressed, again, to take into account the sawing or breaking of part of the stone mass according to planned bead shape-banding patterns; for monochrome chalcedony, on the contrary, we may suppose that attention was mainly focussed on variables such as bead size as opposed to stone texture. The term "breaking" indicates the simple separation of a suitable lump by fractioning the mass with the single constraint of the presence of at least one striking platform for the subsequent reduction. The MNSE Area assemblage contains a group of spheroid chert hammerstones as well as some flakes detached from this type of tools, perhaps used to break the stone masses.

The simplest case is exemplified in Figs. 29, A and 31, in which a pebble is broken in two halves, the fracture surface is used as platform and worked as a kind of rough core (this technique has not been identified in our site). The term "Splitting along diastatic planes" indicates a separation technique specifically monitored for the exploitation of chalcedony defect such as the

strongly fibrous structure and the coarse crystalline banding evident in a large part of the recovered specimens. Fibrous structure determines the existence of fracture lines and, potentially, planes, radially orientated towards the geoid's inner cavity. Banding, on the other hand, when marked by significant discontinuities in its micro-crystalline texture, forms as many diastatic surfaces orthogonally orientated to the former radial lines. This three-dimensional pattern was exploited to break and split the stone directly into squared blocklets, with the result that lump separation actually coincided with rough-out making and, partially, regularization, ruling out most of the chipping phases, with the consequent noticeable hastening of the cycle. The subdivision pattern of fibrous chalcedony is represented, in a highly ideal and simplified scheme, in *Fig. 29*. Such a pattern is here directly produced by a regular, concentric structure of the geoid. G. M. Bulgarelli (personal communication) rightly called my attention to the strong variability affecting chalcedony nodular structure, particularly when stones have been sorted out from alluvial contexts. Nonetheless, the proposed hypothetical reconstruction, after a close examination of a relatively large set of indicators, account for some regularities recognizable across the forming process. *Fig. 29, B* shows the separation pattern resulting from a series of vertical blows applied along the radial fracture lines. *Fig. 29, C* and *D* are series of cortical flakes whose removal allows the isolation of the squared geoid's core, in turn subdivided into the squared elements *E* and *F*. *F*, again, whose median section is formed by the coarse elongated quartz crystals filling the central cavity, may be horizontally split in two symmetrical halves along the central diastatic plane. Elements *E* and *F* (as will be discussed for rough-out smoothing operations) are designed to enclose two different types of beads (*Fig. 30*). Examination of elements of type *C* and *D* reveals that larger and thicker flakes (confront *Fig. 29, D* with *Fig. 32, G, H*) could have been worked as other lumps (*Fig. 32, B, C, D, J, K; Fig. 37, A, E*). As stated above, this reconstruction does not claim to be valid for every form of chalcedony nodule, nor to be predictive for every type of indicator, but to simply account for some recurrent schemes in lump separation.

*Fig. 32, A* is a small geoid with traces of chipping, perhaps aimed to turn it directly into a rough-out. *Fig. 32, B, C, E* are elements corresponding to types *C* of the proposed reconstruction; *D, F, J, K* appear to be lateral flakes deeply penetrating the geoid's core, while *G* and *H* would correspond more closely to type *D*. *Fig. 32, I*, finally, is an element of type *F* with the exception of the chipped nodule *A* and of some chipping traces visible on *D* and *J*, all these remains have simply been discarded after separation.

The other possible way of obtaining directly squared lumps is sawing. Mackay's statement on the employment of metal saws in stone-working has already been

mentioned. Presence and use of bronze-copper saws in Harappan workshops has recently been discussed by Kenoyer (1984: 103) with reference to shell-working. Comparisons with the Minoan world (among others Younger 1981: 31; Bartlett Wells 1974) suggest that such high technological standards were fully available to Late Chalcolithic techno-cultural complexes. In the "Lump separation" column the term "sawing" is followed by a question mark. In the MNSE Area, in fact, we recovered only two stone items with sawmarks: a tablet-shaped alabaster residue and a parallelepiped-like element in a hard, fine-grained metamorphic rock of a greenish colour (*Fig. 33*). Their recovery, although sufficient to demonstrate the employment of bronze-copper saws in the MNSE Area, does not prove their employment in bead-making. In the assemblage there is no evidence of chalcedony sawing. Some rare sawn fragments of this latter material have been found on the surface of other sites of the compound or appear in the Museum Reserve Collection (*Fig. 34*). They document chalcedony sawing for the detachment of thin, translucent plates or stick-like elements which do not immediately fit in the range of bead-making indicators we presently know. Sawing, therefore, has been inserted in lump separation techniques mainly after the evidence provided by the workshops of Chanhudaro, where it was extensively applied to comply with the strict constraints exerted by the forming stages of the long-barrel cylinder beads. The employment of metal saws would have the effect of producing stone rods with continuous, regular striking platforms relegating chipping to a very controlled phase of minute flaking.

Among the other semiprecious stones, serpentine is the only one presenting a lump separation pattern partially similar to that reconstructed for fibrous chalcedony. In *Fig. 35, A* and *B* two squared lumps are reproduced which have been apparently detached with strong blows following large inner diastatic planes. This technique, unlike that for chalcedony, was restricted to the separation of large, rather irregular blocklets for which a further stage of reduction was probably necessary. For jasper, as well as for the rarer rock crystal (whose structure appears generally more compact and homogeneous), we hypothesized simpler breaking operations. The same hypothesis is advanced for the last group, comprehending various types of metamorphic fine-grained rocks. Evidence of sawing in this context has already been discussed.

### 3.4. Rough-out Making and Regularization

In reading the proposed definition of "Lump" one may have observed that it did not depend on a set of clearly defined physical attributes, but rather on a more general evaluation of the element's structural relationship with the sequence chain. Similarly, the proposed definition of "Rough-out" — the element resulting from a phase of physical reduction of the lump accomplished

by series of discontinuous movements — emphasizes the systemic nature of many bead-making indicators, becoming meaningful only when inserted in their transformational trajectory. The definition places "Rough-out" immediately after "Lump" underlining that the lump's transformation in rough-out is carried out with discontinuous movements (chipping and minute flaking) in opposition to the almost continuous movements characterizing the transformation of rough-outs into blanks. The distinction between "chipping" and "minute flaking" is very arbitrary: it has been formalized to express the ideal existence of two subsequent stages of lump reduction, the first one defined by the appearance of the basic form, the second by a careful finishing aimed at levelling the irregularities present on the rough-out surfaces, in spite of the fact that this latter stage is not clearly recognizable in the assemblage under examination. The importance of regularization would lie in the fact that the more the rough-out surfaces are close to level planes, the easier and surer the following grinding stages will be. Part of the recovered rough-outs appear to have been detached with simple breaking and splitting techniques (Fig. 36 A-D), and subsequently chipped to remove the cortical parts (Fig. 36, A, C, D). More effective chipping seems to have been practised in other cases (Figs. 37-39). Defective or broken chalcedony rough-outs represent, after flakes, the most common indicator in the assemblage (Fig. 27). This suggests that chipping phases were characterized by high loss rates, probably due to the presence of the same diastatic planes which were exploited to facilitate the process.

Examination of the rough-outs recovered in MNSE Area as well as in other sites of Moenjodaro reveals that generally they had quadrangular sections (Figs. 36; 37 B, C; 38 A-D; 39 A-C). In other activity areas we recovered some rarer rough-outs with triangular section. A single find in the MNSE Area shows that larger, elongated beads sometimes required hexagonal sections (Fig. 40, e; but note Fig. 40, C, in which the same section is pursued directly by grinding). We have no artefactual evidence of the tool-kits employed in this delicate forming stage. Requisite of chipping stages are the possibility to use a wieldy, light percussion apparatus with tools having minimal contact surfaces with the rough-outs, thereby facilitating the maximum visibility for reduction operations. We might conceive it as an apparatus not very different from the one utilized today at Cambay, where "... a worker chips the stone into a crude shape (a roughout) by bracing it against the tip of an iron stake driven into the ground or a mud floor. He strikes with a flick of his wrist a water buffalo horn hammer mounted on a thin bamboo stick" (Francis 1982: 5).

### 3.5. Rough-out Smoothing, Blank Rounding

The "Blank" is the element produced by a further phase of reduction from a rough-out accomplished by almost continuous movements. Rough-outs result from chipping, a series of discontinuous movements with tools operating mainly in a "positive" sense (i.e. the tool is operated on the processed material — but the particular case of the indirect-reverse percussion method adopted at Cambay should be remembered); blanks are produced by grinding, a series of almost continuous movements in which tools are used in a "negative" sense (the processed material is operated against the grinding tool). The diagram in Fig. 26 takes into account for bead blanks two different transformational stages, respectively defined "Primary Blank" and "Rounded Blank".

Whatever the section, rough-outs undergo continuous grinding of the surfaces, so as to be turned into as many smoothed planes. A "Primary Blank" is then a smoothed element with polygonal section more apt to enclose the rounded form of the bead. As most of the recovered rough-outs have quadrangular sections, the relative primary blanks are more or less regular parallelepiped-like elements simply obtained by rubbing the surfaces onto the parallel grinding planes of the tool (Figs. 35, C, D; 40, F). A "Rounded Blank" is obtained with more subsequent phases of grinding the blank's edges and corners, till the element reaches the designed circular or elliptoid sections (Fig. 40, A-C). This transformation is accomplished with progressive faceting phases, as shown by many of the and/or broken beads (Figs. 35, G; 41, B; 52, A, C, H, K; see also Gwinnet and Gorelik 1981: figs. 4, 14, 16). It will be observed that part of the beads entered drilling process before a complete rounding took place, as documented by Gwinnet and Gorelik for the industries of the Iranian sites of Shahr-i Sokhta and Hissar (1981: 21). Probably this latter task was conceived as pertaining to the polishing process.

Grinding traces on rough-outs are rather frequent; they document several unsuccessful attempts to turn them into blanks, thereby probably marking another critical point of the manufacturing sequence. An examination of them allows a closer look at certain aspects of the smoothing operations. Serpentine elements, being relatively soft, retain very clear rubbing traces. Fig. 35, C is a rough-out which, being most probably already defective after chipping, has been discarded after undergoing further damage in grinding. The four major faces have more or less extended ground surfaces; the rubbing direction follows the main axis of the piece (cf. Gwinnet and Gorelik 1981: 19). In this case, the element was to have assumed a convex profile already in the form of primary blank. A second fragmentary specimen of the same stone (Fig. 35, D), broken apparently in analogous circumstances and retaining the same profile, suggests that such shapes were

recurrent in this transformational stage. *Figs. 35, G and I*, document facetting stages, respectively, for beads and gamesmen. *Fig. 35, H* is a small primary blank with slightly convex faces, bearing traces of an incomplete horizontal groove at 1/3rd of its height. *Fig. 40, A-C* show three interesting examples of broken and split chalcedony rough-outs which have directly been worked as primary blanks, grinding the edges (*Fig. 40, A, C*) and the corners (*Fig. 40, B*). In the three cases, anyhow, it is clear that the operation planed the whole face of the element, wearing away the cortex remains (*Fig. 40, A, B, D*) as well as the surfaces formed by the coarse-crystalline diastatic planes exploited for lump separation (*Fig. 40, C*). Cortex remains are still visible on the specimen in *Fig. 40, D*, which was almost completely smoothed when the blank broke down along an inner white vein. *Fig. 40, F* shows a heliotrope primary blank smoothed, like in the case of *Fig. 35, C* all over the 4 main faces, and severely damaged in rubbing. Another chalcedony blank, this time already rounded, and broken in rubbing along an inner vein is shown in *Fig. 41, A*.

One of the most interesting aspects of this operation is represented by the exploitation of carnelian-agate banding pattern (*Figs. 30, 42*). Grinding, in this case, was not only monitored to smooth-off geometrical or structural irregularities of the rough-out, but was critically accomplished according to specific aesthetic models, exposing surfaces with regularly arranged, attractive chromatic contrasts. *Fig. 42, B* demonstrates how elements of type *E* and *F* (cf. *Fig. 30*), separated by breaking the geoid in specific points, might be designed for the production of two different types of beads: a first type having the axis orthogonally oriented to the bands' direction, which, due to their position in the *E* section of the nodule, retain beautiful concentric bandings, and the so called "eye-stone" beads, with the central axis running parallel to the bands' orientation; in this latter variety the superimposition pattern of bandings is carefully followed by a gentle rubbing with a cameo-like technique, exposing sometimes a single band for all a blank's face. Such beads seem to have been intensively produced in the site's working unit, but this evidence could also be due to the recurrent problem of the blanks' particular fragility.

*Fig. 42, A, B* are two fragmentary carnelian-agate rough-outs manufactured according to the described model. *Fig. 42, C-H* are all fragmentary rough-outs broken in grinding; it appears evident how carefully the artisan isolated the red band in the center of the blank, in the concentric framing of the other lighter zones (see also *Figs. 43-44*). *Fig. 42, I* is a small flake of moss-agate worked with a similar concept. The remaining pieces of *Fig. 42* document in rough-out form (*J*) and as fragmentary blanks (*K, L*) even more complex solutions in which the main bead axis is orientated according the banding direction, while the

minor axis had been diagonally inclined, allowing other decorative patterns.

The "bead-stones" identified by Mackay at Chanhardo have already been mentioned. The tools utilized at Moenjodaro for the same purpose have been identified in some re-utilized grinding stones bearing clear evidence of highly polished surfaces interrupted by series of radial or parallel grooves (*Figs. 46-48*). According to the proposed reconstruction, continuous smooth surfaces in the bead-working tools were determined by transformation of rough-outs into primary blanks, through continuous grinding of parallelly orientated planes; the grooves, on the other hand, would have been formed by the subsequent rounding of the same blanks by smoothing-off edges and corners, as well as by prolonged rubbing of small blanks with rounded central section.

The first specimen *Figs. 46, left; 47*) is a red quartzite piece resulting from the re-utilization, after breaking, of one of the more common grinding stones so common in the Moenjodaro houses; it was collected from the old excavations dumps north-east of the HR Area. It is roughly circular in shape, and bears five grooves of no more than 2 mm. in depth. The opposite face presents the coarse surface these tools normally have in their primary utilization. The second bead-rubbing tool (*Figs. 46, right; 48*), again in red quartzite, has been recovered in the DK-B, -C dumps. Apparently this fragment belonged to a larger elongated grinding stone, re-utilized before breaking. It has three grooves orientated with the main axis of the tool. In this case, they are deep and regular enough to suggest that series of beads were contemporary smoothed in them by pressing with a wooden tablet; the described technique was commonly adopted at Cambay before the introduction of continuously revolving mechanical wheels. In this specimen the functional surfaces relative to bead-rubbing have been almost completely destroyed by later punching and hammering phases in which the piece was used as an anvil, receiving a dense pattern of sub-circular depressions all over its faces. These dynamics of continuous re-utilization with changing functions are particularly evident in the third tool, recovered, this time, on the surface of MNSE Area (a similar case of prolonged utilization of heavy polished stone tools with progressive modifications, contrasting with the simpler use and discard of flaked stone tools, is described in a different cultural context in White and Modjeska 1978). The tool (*Figs. 49-51*) is a heavy block of fine-grained sandstone with a grayish colour, originally belonging to a large and thick grinding stone which, as shown by the rough surface of its inferior face was originally designed to be embedded into a clay bench or floor. After breakage, part of the tool was adapted to other functions; visible along the breaking surfaces (*Fig. 51*) are the traces left by the detachment of few large flakes to regularize the tool's shape. The stone presents

an irregular ogival contour, with a major flattened, slightly concave functional face; the distal extremity and one of the side faces are noticeably convex and highly polished, while the remaining lateral face bears characteristics rather similar to those of the main face. Here the stone has a shallow circular depression, probably left by beating and revolving a spheroid pounder or hammerstone. Its central position could suggest that it was left after the tool's breakage. The central depression is partially disguised by a series of traces which, on the main face, appear to have been produced by an intense phase of punching/hammering, in the form of small, elongated depressions whose size suggest a rather limited contact surface between the stone and the beating body. The traces are more frequent on the lower section of the main face. They have an average orientation of  $22^\circ$  ca. with the main axis of the stone. The described features indicate that a squatting worker used the tool as an anvil, keeping the basal fracture surface immediately in front, with the stone lying horizontally. A similar pattern of traces is visible on the flattened side face reproduced in Fig. 50, demonstrating that the tool was easily moved to exploit its various functional surfaces. This latter side, as well as the main face, appear to have later been employed in bead-making. Close examination of the surface revealed the presence of some irregular, shallow groovings analogous to those identified in the former specimens. The grooves' shallowness may indicate that the tool's employment with this function was not a very prolonged or intensive one. As a matter of fact, all pre-existing traces were subsequently erased by a general polishing of all the stone's faces, particularly effective on the rounded extremity and on the convex side face; this polishing is very uniform, and could be the result of long abrasive operations on continuous surfaces such as the ones, for example, provided by leather. Finally, the rounded tip of the stone was strongly damaged by a series of five-six strong blows testifying the tool's occasional return to an anvil-like function.

### 3.6. Drilling and Polishing

A handful of beads broken in perforation was recovered from the site's surface. Some of the specimens (Figs. 35, G; 43; 52, A, B, F; 53) are beads split in two parts in the first stages of drilling by excessive pressure; in other cases (Fig. 52, G, J) only a very detailed examination of millimetric splinters revealed the presence of sectors of the perforation hole. In the case attested by Fig. 52, J we may imagine a kind of explosion of the drilled blank. Fig. 52, A, C, D, as already stated in paragraph 3.5., show how some beads underwent drilling before the forming process was completed. Fig. 52, E is a primary blank in jasper which, after perforation had been suspended on one extremity (Fig. 54), and badly performed at the opposite one, was finally discarded.

If we consider the artefactual evidence of the drilling tool-kits, we find a disproportionate amount of data on the drills' points as opposed to the paucity on the sophisticated system presumably employed in the process, whose ingenious organization may be imagined (Salvatori and Vidale 1982) but the employment of micro-drills on blade for the perforation of long beads of the harder stones of the silica series has not yet been proved. According to Mackay (1937: 5) the coincidence of chert micro-drills on blade and phtanite ones at Chanhudaro could be explained by articulating the drilling process into two distinct operations: scratching the drill-guide depressions and actual drilling. Although the technological analysis of the large collection of chert drill-heads will yield new substantial evidence, possibly revealing a multi-functional pattern of utilization, we will preliminarily follow Mackay's suggestion, hypothesizing that at least a part of the drill-heads were used in tracing the starting scars for subsequent drilling (Gwinnet and Gorelik 1981: fig. 12). We cannot rule out, on the other hand, that such drill-heads were also operated onto beads of softer materials like, for example, limestone or serpentine.

The ratio of sub-cylindrical phtanite drill-heads versus chert specimens can be approximately evaluated to 1:25, defining the former type as a very rare one in the MNSE Area. This type of tool is well known since Mackay investigations at Chanhudaro; it has subsequently been described at Shahr-i Sokhta (Piperno 1973; Tosi 1973: Figs. 2, 5; Piperno 1976: Figs. 2-4; Piperno 1981; Gwinnet and Gorelik 1981: 23), Mehrgarh (Jarrige 1981: 109) Mundigak (Jarrige and Tosi 1981: 135), and Shahdad (Salvatori and Vidale 1982: 8-9, Fig. 3). As attested for the chert specimens, phtanite drill-heads were manufactured, apparently, in the same context of the bead-making cycles. The greatest part of the recovered phtanite is represented by waste flakes (Fig. 56); less common are lumps (Fig. 57, left), rough-outs (Figs. 57, right; 58) and finished and utilized drill-heads (Figs. 60-63). The tools were manufactured out of rod-shaped, square-sectioned rough-outs, probably detached in turn from squared lumps (Fig. 57), although the separation technique is not clearly recognizable. The rough-outs generally present a continuous, abrupt re-touch along the four main faces. An examination of the recovered flakes revealed the presence of the thin, scale-like elements detached in forming the rods (Fig. 59). One of the recovered specimens, anyhow, presents continuous unretouched surface more difficult to interpret (Fig. 57, extreme right). Like the analogous rough-outs from Shahr-i Sokhta (Piperno 1973: 120) the Moenjodaro drill-heads show a narrowing contour in correspondence with the designed working end. The analysis of the collection of utilized drill-heads allowed us to draw some relevant conclusions. In confuting Mackay's assertion that Chanhudaro drills were formed by "... grinding them in much the same way as the beads" (1937: 6) Piperno (1973: 120-123) tries to account for

Mackay's mistake. As a matter of fact, as the Chanhudaro specimens are identical to those from Moenjodaro (Sher and Vidale 1985) we may now argue that such an interpretation was drawn from the fact that, unlike the Shahr-i Sokhta specimens, Harappan drill-heads were carefully smoothed on the hafting section, as described by Mackay in the following sentence: "...the butt... more often than not has slightly faceted sides, to prevent its turning in the handle or chuck in which it was fixed" (1937: 6). The point is illustrated in Fig. 60 A-E, H-J. All these phtanite drill-heads from the MNSE Area have a hafting part sectionally square (A, C, E, H, I, J) or polygonal (B, D) contrasting with the roughly chipped surfaces of Shahr-i Sokhta drills (Piperno 1973: figs. 9.1, 9.2). The reasons of this choice on behalf of the Harappan lapidaries probably lie more in the need to maximize control on the points' centering than in preventing it from turning inside the handle, as the rough hafting part of the drills from Sistan doubtlessly granted a better resistance.

Very few specimens were recovered in a state of completion. The remaining collection is formed by broken cylindrical points (Figs. 60, F, G; 61; 63), specimens fragmentary of the upper hafting section (Figs. 60, B, C, H; 63) and broken hafting sections (Figs. 60, D, E, I, J; 64, 65). The analysis of this latter group leads to the identification of a probable new type of indicator. A certain number of fragments of the hafting section was characterized by rounded convex extremities, with clear traces of rotatory friction (Figs. 60, I, J; 64, 65), whose shape and size contrasted with the features commonly encountered in the tips of the working ends. In some cases (Fig. 60, I, J) the elements had both the extremities rounded, showing that the drill-head fragments had been re-utilized twice. Another outstanding feature of the rotatory wear traces was that their inner rotational axis was not always orientated with the central axis of the drill piece (Fig. 60, I). The probable explanation of the function of these elements would be in an ethnographical comparison with the Nagara drills (Fig. 66). The drill is provided with an upper small pivot in copper protruding from the wooden handle extremity and centered with the drill-head. The pivot rotates against a coconut shell cap used by the worker to press the revolving tool against the bead blank, thereby assuming a rounded convex tip (Fig. 66, C). The data from the MNSE Area, therefore, could indicate that broken drill-heads were re-utilized as upper pivots.

In the list of the finds from the old excavations there are more possible candidates for the identification of the drill-caps which presumably were characterized by a wide typology. Kenoyer (1984) has recently published a thick piece of *Lambis* shell bearing a series of shallow circular depressions analogous to those visible on the interior of the coconut shell in Fig. 66, B, clearly indicating its function. A possible drilling stone-cap of great interest because it was recovered with other possible stone-working indicators (see foot-

note 1) was classified by Mackay (1938: 412) as a "pedestal"<sup>6</sup>. The piece is marked DK 12390; together with the almost identical piece DK MM 653 (Figs. 67, 68) it is now conserved in the Moenjodaro Museum collection. Both the pieces are odd hemispherical objects in compact limestone, bearing a major cylindrical hole in the center of the top and a second similar hole departing from the border. The surface is covered with an uninterrupted network of small circular depressions ranging in diameter from 1.6-1.8 to 4.7-6.0 mm. The depressions could well represent the traces left by an upper drill-pivot. The pattern of distribution of such traces is characterized by localized clusters of depressions with the same diameter, indicating the frequent consecutive repetition of the same operation; within the same cluster, the inner axis of the holes is very variable, showing possible changing orientations of the worker's wrist, and recalling the divergence in orientation observed between the pivot's axis and the rotatory wear trace in some of the specimens. In both the pieces, the uneven surface created by the depressions was later smoothed off, possibly with the purpose of creating a new starting platform for the pivot.

To conclude the discussion on the artefactual evidence of drilling, an observation on the much debated question of the central depression on the tip of the working-ends of the phtanite drills (Mackay 1937: 6-7; Piperno 1973: 124-126; Gwinnet and Gorelik 1981: 23). This feature is present in all the points we recovered, with the exception of the one reproduced in figs. 60, H and 63, in which the opposite feature of a small nipple is clearly visible. The structural character of this opposition recalls the results of some experiments of Gorelik and Gwinnet (1978: Fig. 12, D, B), supporting Piperno's interpretation of the tip feature as a by-product of the interaction between the variables and constraints internal to the physical systems of drilling. On the other side, as this variability of the tip form is probably a direct function of the relationships between the petrological characteristics of the tool and the processed stone, it further underlines the composite nature of the MNSE Area stone-working industry.

We have no evidence of the polishing process, whose traces are hardly discernable even by SEM inspection (Gwinnet and Gorelik 1981: 23). It is commonly hypothesized that this process was accomplished by tumbling the beads in leather bags with abrasive mixtures (Mackay 1937: 9; Tosi and Piperno 1973: 20), according to procedures similar to those described by Trivedi (1964: 16).

### 3.7. Other Technological Aspects

Separate mention is deserved by the scanty evidence we have on lapis lazuli bead-making, represented by a couple of flakes and a single small rough-out lost or discarded after perforation (Fig. 52, I). Comparing

the position of this rough-out with the reconstruction available for the other materials (Fig. 26) we may observe the anomalous behaviour of the lapis lazuli sequence. The rough-out is a squared blocklet probably designed for a disc-bead, separated by splitting, which had to be perforated before any polishing took place, thereby conforming to the reconstructed trajectories of lapis lazuli bead-making at Shahr-i Sokhta (Tosi and Piperno 1973: 19) and Hissar (Bulgarelli 1974: 26) and more recently recognized at Shahdad (Salvatori and Vidale 1982: 8).

We have already mentioned the possible presence, together with bead-making, of manufacturing cycles relative to other classes of objects, as in the case of the serpentine gamesmen of Fig. 35, I.

A second type of object produced in the MNSE Area was the cube-shaped chert micro-weight in banded chert; the surface collection allowed the recovery of an unexploited lump and two broken chipped rough-outs (Fig. 71), as well as a certain amount of flakes of the same distinctive material. The cubes were chipped into shape, smoothed as primary blanks and polished. Close inspection of the micro-debitage recovered by sieving showed the presence of series of small chips with smoothed and/or polished surfaces. If pieces like Fig. 72, A-F could be part of bead blanks, a faceted fragment like Fig. 72, G would confirm the impression of the contemporaneous occurrence of different types of products.

Fig. 73 collects a part of the bronze-copper fragments so far recovered. All the pieces are very small and non-diagnostic, due also to their bad state of oxidation. A great part of the fragments are small particles of sheets such as Fig. 73, A. Possible rod-like elements suggesting small chisels like Fig. 73, B, C, D, H (note that D and H could bear a kind of functional end) are rarer. Other fragments could belong to pins, nails or wires (Fig. 73, F, G, I) and provide no more clear evidence. It should be stressed that a point like Fig. 73, G could also, theoretically, be a drill-head, but its strong oxidation, together with the pieces inner fragility, would render any inspection very difficult.

### Concluding Remarks

The paper has tried to outline the technological component of the MNSE Area semiprecious stone industry, as it appears from the surface record, within the wider context of the town's lapidary craft production. Although the proposed reconstructions are still largely fragmentary and sometimes simply conjectural, the analysis underlined the composite character of the semiprecious stone-working assemblage, pointing to a relatively high degree of complexity in the space/time organization of labour by the Harappan production unit(s) under examination. This degree of complexity would become even more meaningful if we take into account the components of the artefactual record

which have been ruled out from the present study (in first place a significant group of specialized retouched and/or worn chert tools not immediately related to bead-making) as well as if we consider how frequently in the interpretation of some classes of indicators we could hypothesize the intervention of quite different production cycles. If the secondary context of the surface distribution will be confirmed by the current researches, we are going to face a basic question: how is the outlined technological complexity reflected in a disposal context? Such a question could also be enlarged to a more general one: to what extent the secondary depositions common at Moenjodaro may spread light onto the organization of labour in craft production? In the next future, a significant part of our efforts at Moenjodaro will be monitored to provide a first set of answers.

### Footnotes

1. Considering the published list of finds, Block 6A, DK-G South may be taken as a good example of a possible "workshop" reconstructed by this type of approach (see Mackay 1938: 75-77). One observes that, out of the 10 unfinished beads listed in our Tab. 1, two had been found in the same building (Mackay 1938: 502). The list of the other antiquities recovered in this context goes as following:

TYPE OF OBJECT	PLATE	ROOM	DEPTH
Ivory Awl	CV, 13	42	-10.7
Pottery Bulla	CXL, 34	35	-10.4
Copper Pan	LXXII, 10	39	-10.3
Limestone Pedestal	CIV, 23	42	-9.2
Copper Dish	CXXII, 6	40	-8.9
Whetstone	CVI, 21	41	-8.8
Pottery Kohl-jar	LVI, 4	43	-8.8
Ivory Fish	CXXXVIII, 52	34	-8.6
Bronze Saw	CXIX, 10	33	-8.3
Copper(?) Axe Frag.	CXX, 31	33	-8.3
Faience Pin-Head	CXXV, 32	39	-8.1
Copper Arrow-Head	CXXV, 46	33	-7.8
Cover-Brick	LIV, 15	42	-6.0
Mace-Head(?)	CIV, 5	41	-5.5
Painted Jar	LVI, 36	40	-5.6
Agate Die	CXL, 63	41	-5.6

(note that the two unfinished beads previously mentioned were not included by Mackay in the present list).

Now, if we think that, as discussed in paragraph 3.6., the limestone pedestal could be interpreted as a kind of stone drilling cap, and that the list could include a hone found in the street between Blocks 6A and 25, not far from a door of the building (Mackay 1938: 406), as well as a chisel (*ibidem*: 457), not reported in the list but apparently found in room 33, and, finally, that the Mace-Head is unfinished, the resulting picture would recall another lapidary's workshop (in spite of the altimetric dispersion of part of the indicators).

2. In the present paper, as in many other reports, the two terms "heliotrope" and "bloodstone" are equivalent.

- 3 Both grave PG/958 at Ur and G.77 at Shahr-i Sokhta contained some tools and wasters in more common materials such as a broken palette in white limestone, limestone flakes, some pebbles at Ur (Woolley 1934: 207) and a sandstone grinder together with a cortical flake from a pebble at Shahr-i Sokhta (Piperno 1976: 10).
- 4 In drawing the lithic indicators reproduced in Figs. 32, 36-42, 52 I had to face the very particular problem of combining graphically the different spheres of information relative to the chipping technique, the presence of inner features of the stone such as the presence of cortex or coarse diastatic planes, as well as to express, for the agate elements, the structure of chromatic contrasts which, sometimes, turned out to determine the orientation of the bead. I have tried to overcome this difficulty by drawing the volumetric chipping features according to the usual standards of lithics' graphic reproduction, limiting the interpretation to the critical features; cortex portions are characterized with irregularly dotted areas, while the parallel diastatic planes exploited in the forming phases are expressed with uniform dotted surfaces (for example, Fig. 38, A; Fig. 40, A, C). For what concerns chromatic contrast in agate banding I have decided, like in the case of the chipping features, of marking only the attributes which could be deemed culturally significant. Given the author's scarce experience in the field of lithics' reproduction, the results are open to every criticism.
- 5 "No. 23 (DK 12390) (see also Pl. CXXV, 34). 1 in. high by 2.56 ins. in diameter at the base. Grey, cherty limestone. At first glance this hemispherical object looks like a piece of natural coral, for, except its smooth, slightly convex base, it is covered all over with a number of shallow pittings which vary in diameter from 0.19 in. to a very small size. These pittings are irregularly placed and a trefoil occurs here and there. In the middle of the top of this stand there is a shallow depression, 0.12 in. deep and 0.45 in. in diameter in whose floor is a hole, 0.2 in. in diameter by 0.5 in. deep. A second hole cut horizontally in the side of the stand is 0.16 in. in diameter by 0.65 in. deep." (Mackay 1938: 412).

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Fig. 1

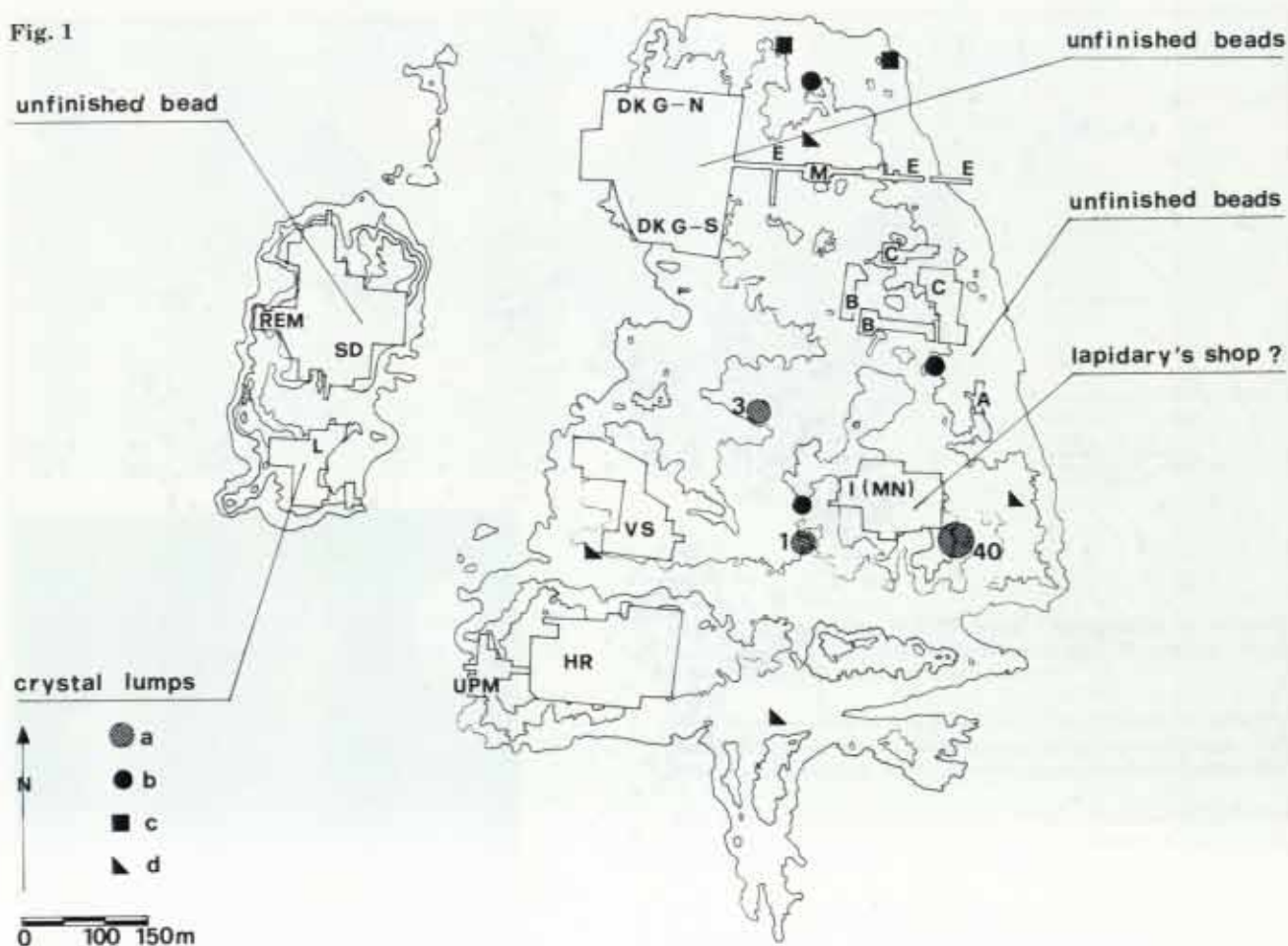


Fig. 1 Moenjodaro. Distribution of semiprecious stone-working indicators according to the early excavation reports and the preliminary data from the surface survey: a. Major Craft Activity Areas involved in semiprecious stone-working; b. Minor concentrations with bead blanks; c. Isolated chalcedony blocks or lumps; d. Minor concentrations of flakes.

Fig. 2 Moenjodaro. Chalcedony rough-outs in the Moenjodaro Museum Reserve Collection.

Fig. 3 Moenjodaro. Bead blanks in jasper, chalcedony and other semiprecious stones in the Moenjodaro Museum Reserve Collection.

Fig. 2



Fig. 3



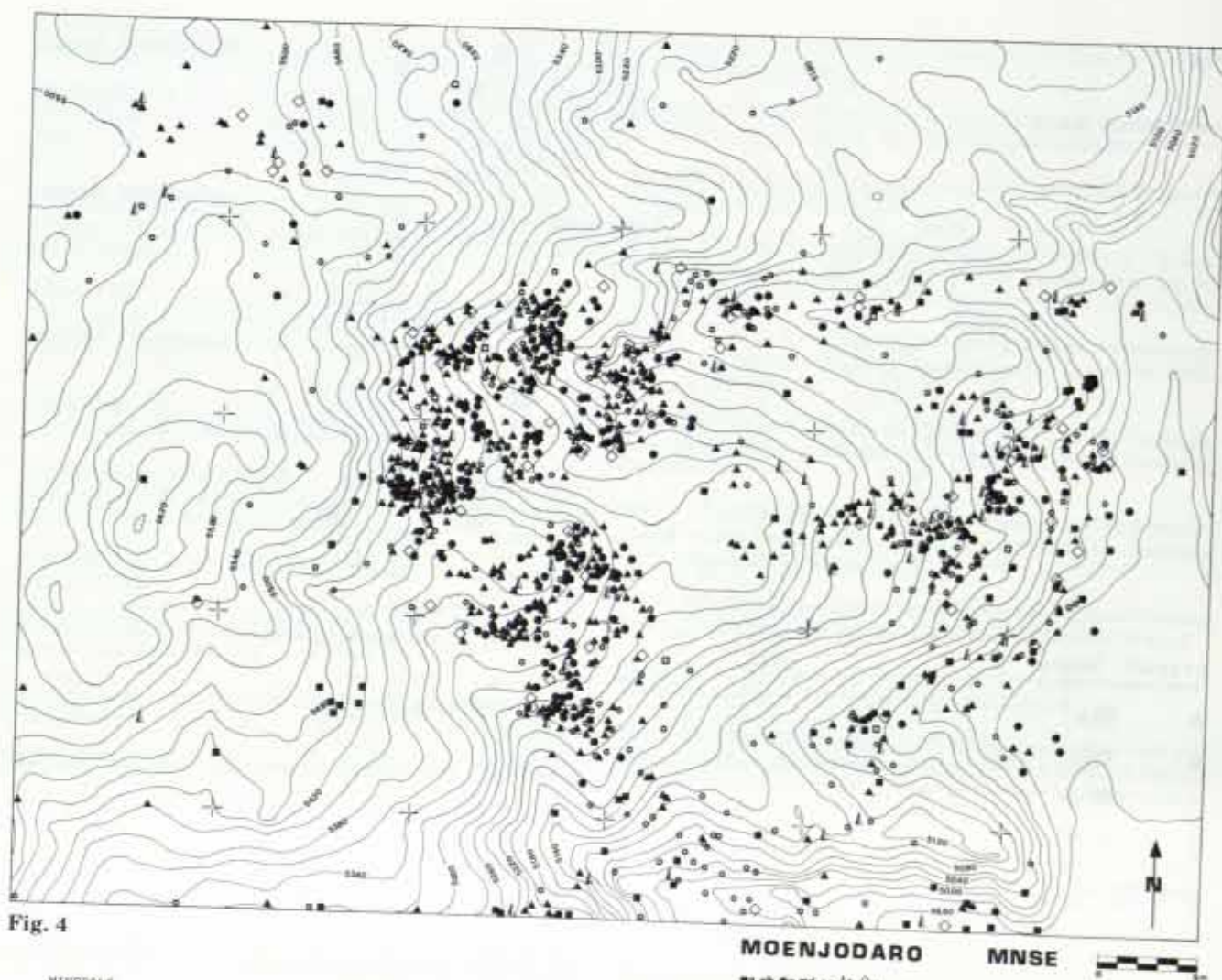


Fig. 4

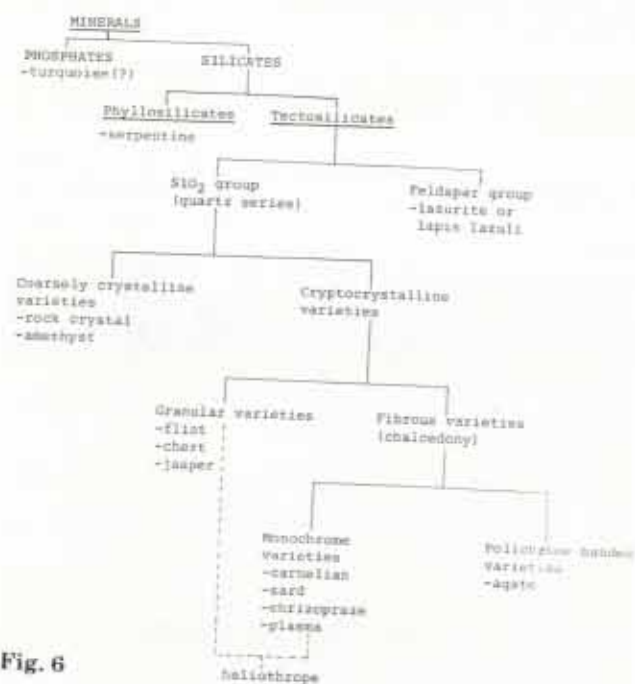


Fig. 6

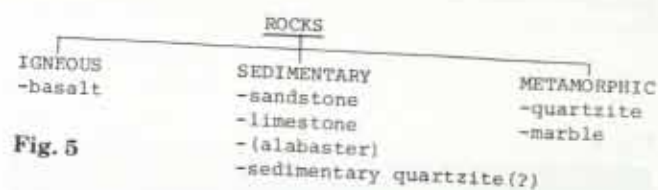


Fig. 5

Fig. 4 Moenjodaro, MNSE Area. Distribution map of selected classes of semiprecious stone-working indicators: a. Quartzite flakes; b. Chert blades; c. Chert and phthanite drill-heads; d. Unfinished chert drill-heads; e. Chalcedony debitage; f. Jasper debitage; g. Serpentine debitage.

Figs. 5, 6 Classification of the identified materials according to Dana's system (Hurlbut 1959).

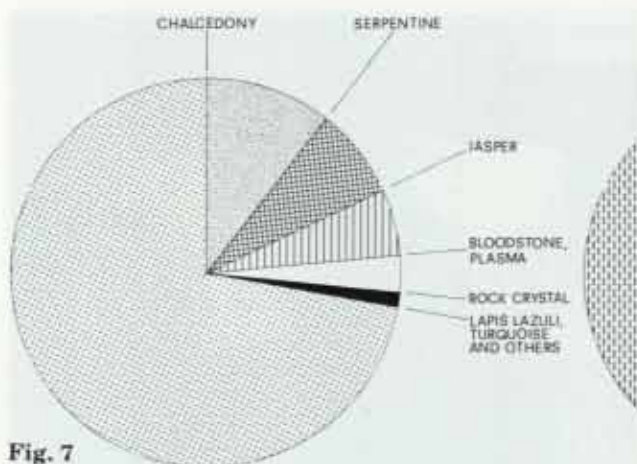


Fig. 7

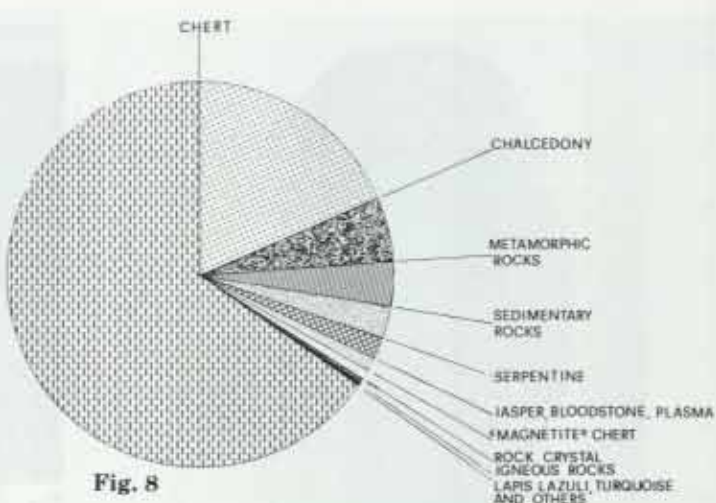


Fig. 8



Fig. 9

Fig. 10

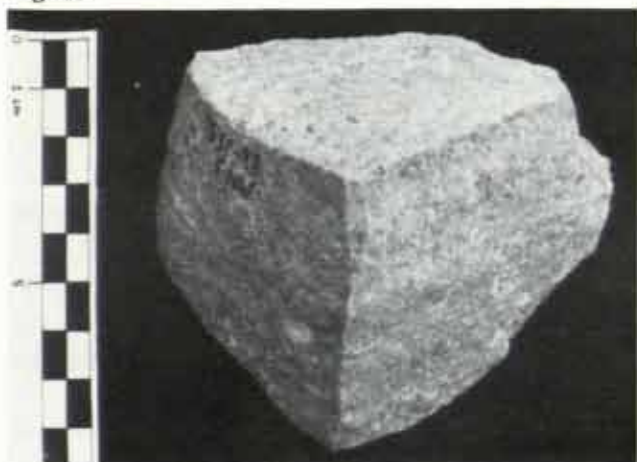


Fig. 7 Moenjodaro, MNSE Area. Composition in relative percentages of the total lithic assemblage. "Magnetite" chert is Mackay's definition for phtanite.

Fig. 8 Moenjodaro, MNSE Area. Composition in relative percentages of the semiprecious stone assemblage (but sedimentary, metamorphic, igneous rocks, chert and phtanite).

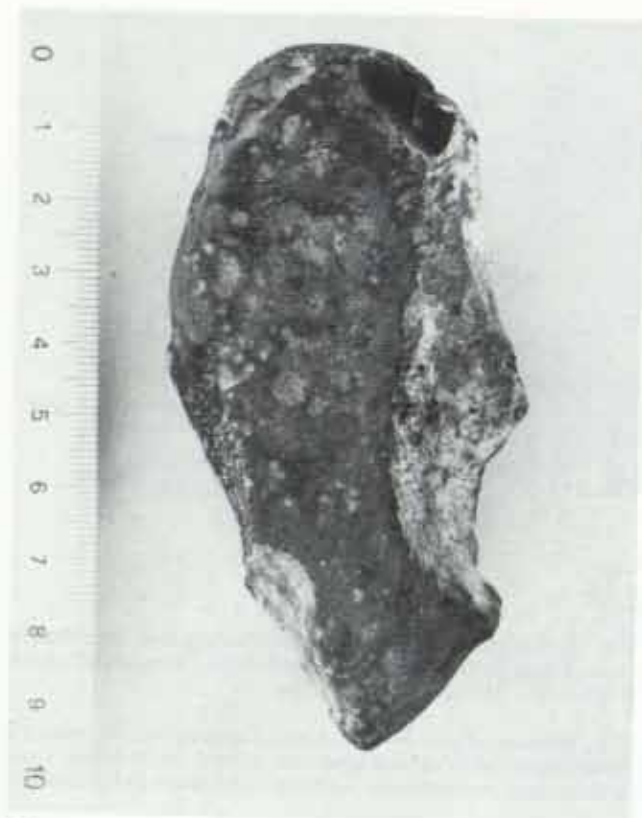
Fig. 9 Moenjodaro, MNSE Area. Group of artefacts collected from a 1x1 m. unit, showing the high incidence of chert tools and wasters.

Fig. 10 Moenjodaro, MNSE Area. Fragment of a quartzite grinding stone. Flakes detached by tools of this type are a very common find on the surface of the site (see also Fig. 4).

Fig. 11 Moenjodaro, MNSE Area. Small chalcedony lumps in the form of broken alluvial pebbles.

Fig. 11





**Fig. 12**

**Fig. 15**



**Fig. 13**



**Fig. 14**



**Fig. 12** Moenjodaro, MNSE Area. Chalcidony alluvial pebble with chipping traces.

**Fig. 13** Moenjodaro. Large chalcidony fibrous blocks from the Moenjodaro Museum Reserve Collection.

**Fig. 14** Moenjodaro. Large chalcidony fibrous block from the Moenjodaro Museum Reserve Collection.

**Fig. 15** Moenjodaro, MNSE Area. Cortical flakes from chalcidony pebbles from the surface collection.

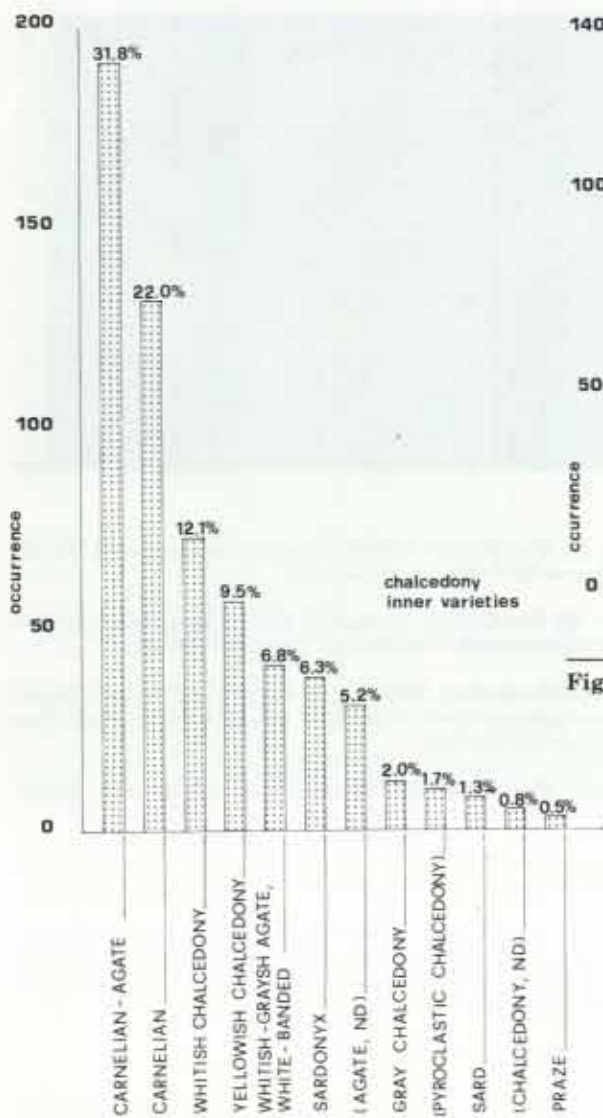


Fig. 16

Fig. 19

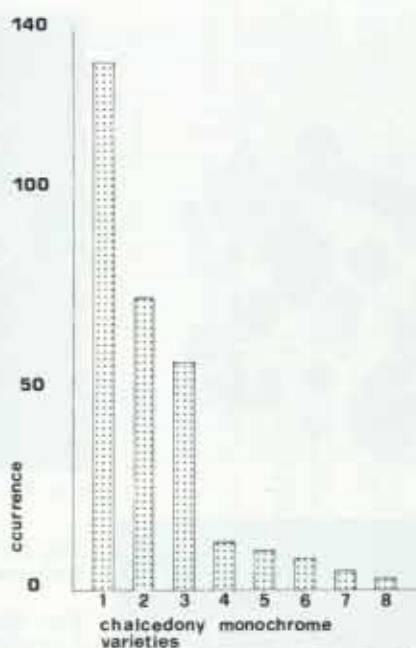


Fig. 17

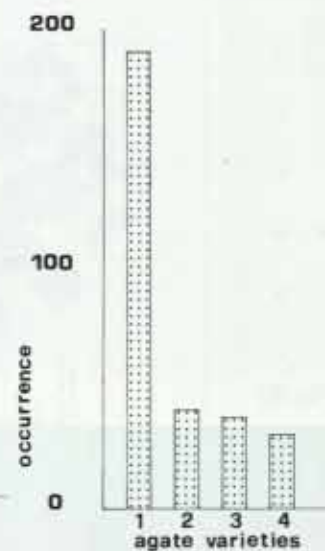


Fig. 18

Fig. 16 Moenjodaro, MNSE Area. Relative incidence of chalcedony internal variety in the assemblage from the surface collection.

Fig. 17 Moenjodaro, MNSE Area. Incidence of chalcedony monochrome variety in the assemblage from the surface collection. 1. Carnelian; 2. Whitish chalcedony; 3. Yellowish chalcedony; 4. Grayish chalcedony; 5. Pyroclastic chalcedony; 6. Sard; 7. Not determined; 8. Praze.

Fig. 18 Moenjodaro, MNSE Area. Incidence of agate varieties in the assemblage from the surface collection: 1. Carnelian-agate; 2. Whitish-grayish agate; white-banded; 3. Sardonyx; 4. Not determined.

Fig. 19 Moenjodaro, MNSE Area. Serpentine debitage from the surface collection.

Fig. 20 Moenjodaro. Jasper lumps from various localizations of the site (surface collection 1982-83).

Fig. 20





Fig. 21



Fig. 22



Fig. 23

Fig. 21 Moenjodaro, MNSE Area. Jasper debitage from the surface collection.

Fig. 22 Moenjodaro. Lumps of rock crystal from various localizations of the site (surface collection 1982-83).

Fig. 23 Moenjodaro, MNSE Area. Rock crystal flakes (left) and quartz splinters from chalcedony geoids' core recovered from the surface collection.

Fig. 24 Moenjodaro, MNSE Area. Composition of the assemblage recovered by sub-surface stripping (see paragraph 2.3.): C. Chalcedony; P. Phtanite; LM. Limestone; Q. Quartzite; S. Serpentine; B. Bloodstone (heliotrope), plasma, etc.; J. Jasper; I. Igneous rocks; R. Rock crystal; L. Lapis lazuli and others.

Fig. 25 Moenjodaro, MNSE Area. Composition in relative percentages of the semiprecious stones assemblage recovered by sub-surface stripping (but sedimentary, metamorphic, igneous rocks, chert and phtanite: cf. Fig. 24).

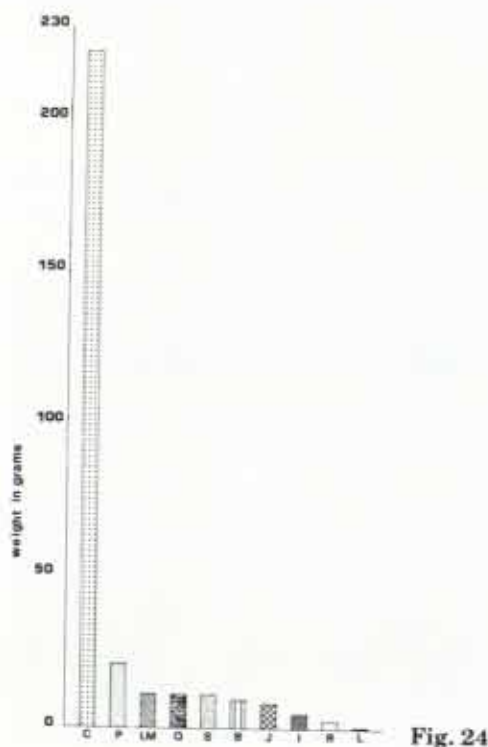


Fig. 24

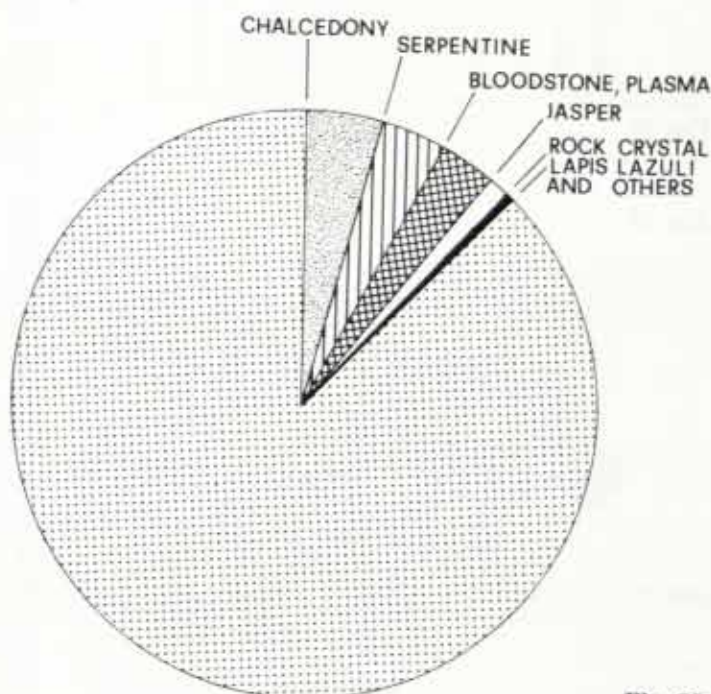
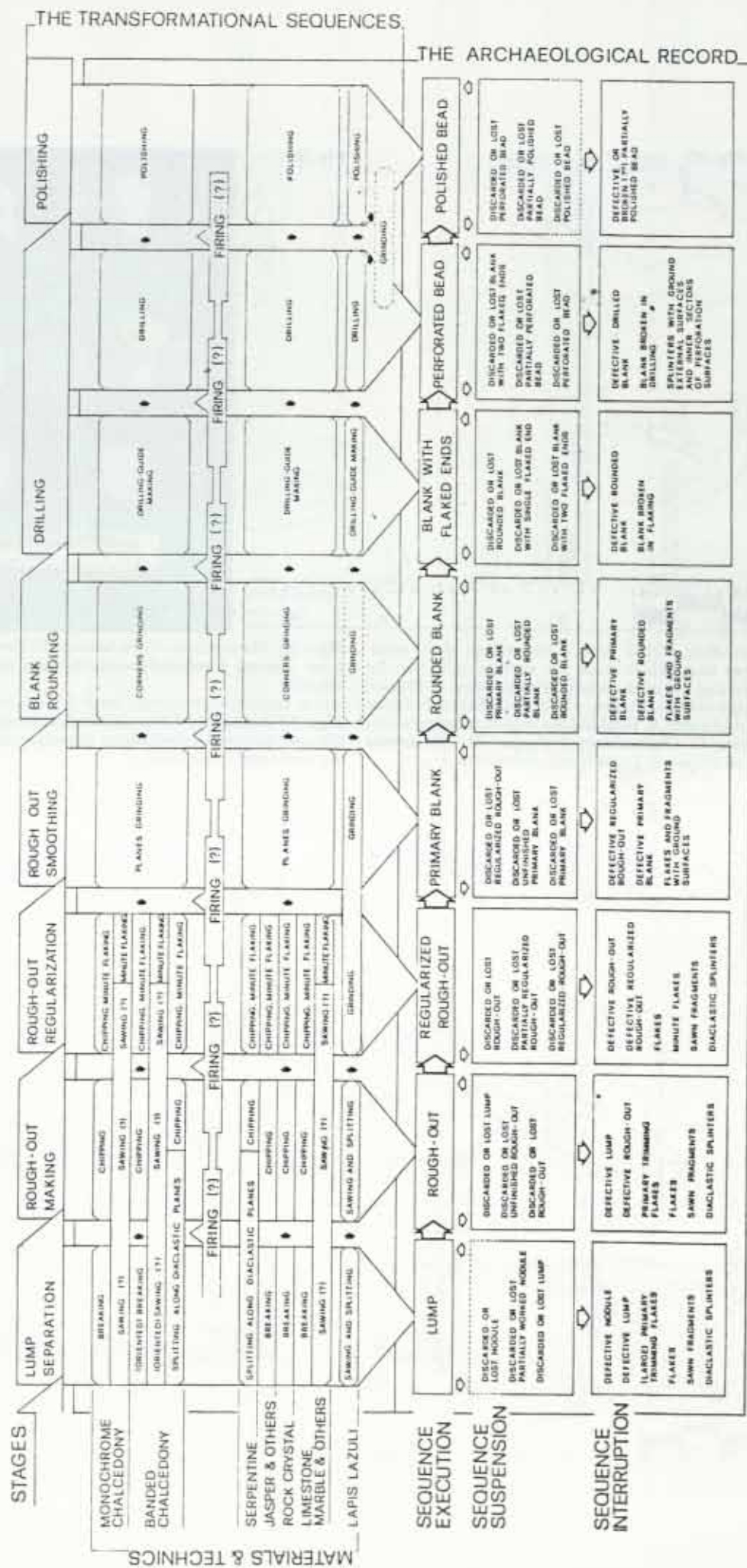
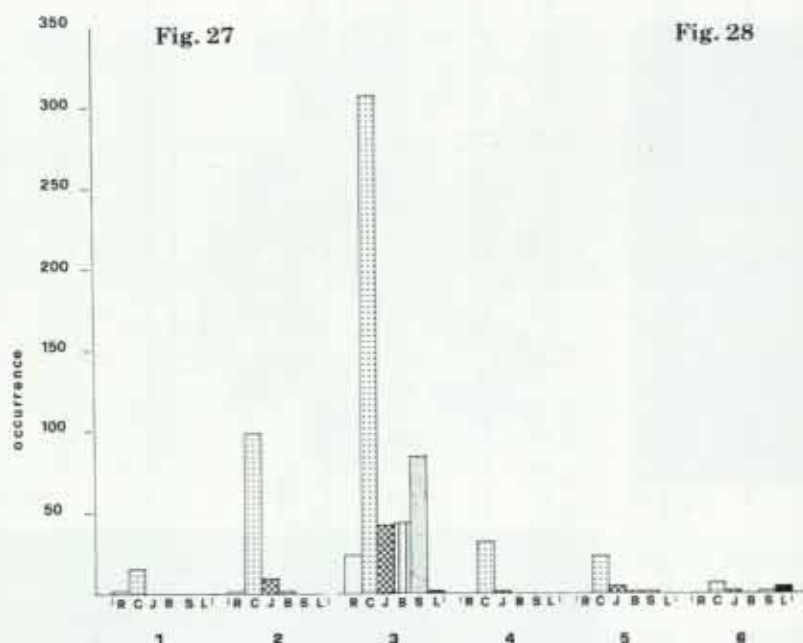


Fig. 25

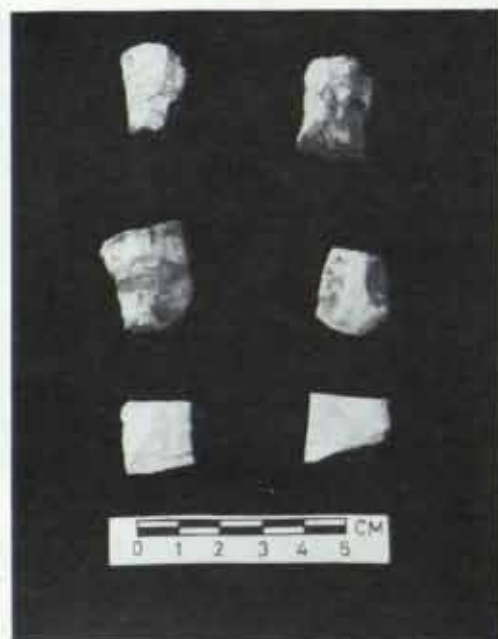
**Fig. 26** Flow diagram representing the transformational sequences recorded in the MNSE Area and the relative artefactual evidence (for explanation see text).





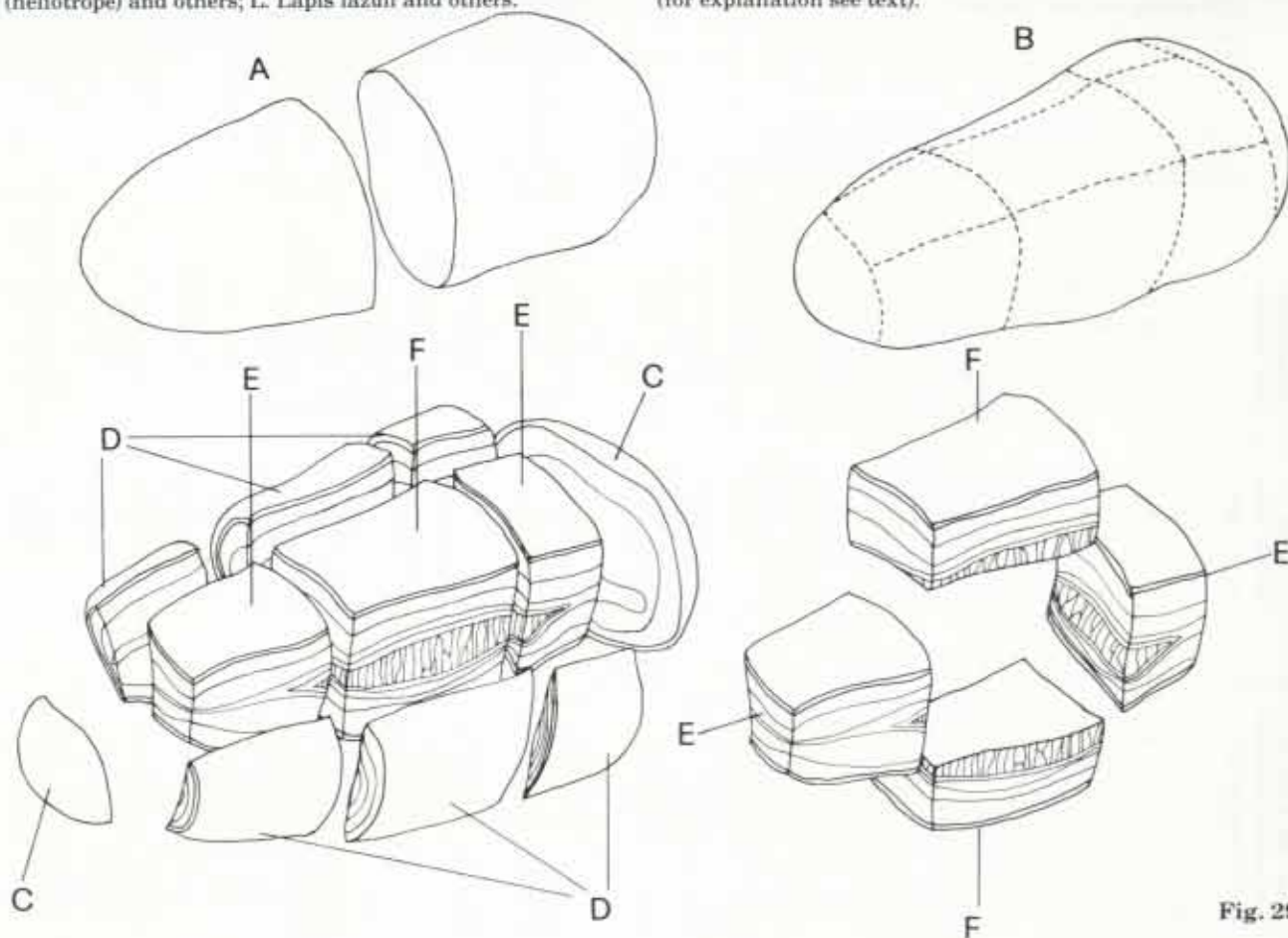
**Fig. 27** Moenjodaro, MNSE Area. Composition of the semi-precious stones assemblage from the surface collection by stone varieties and selected classes of indicators: 1. Blocks, lumps; 2. Rough-outs; 3. Flakes; 4. Cortical flakes; 5. Inner flakes from geoid's core; 6. Bead blanks broken in perforation. R. Rock crystal; C. Chalcedony; J. Jasper; B. Bloodstone (heliotrope) and others; L. Lapis lazuli and others.

**Fig. 28**



**Fig. 28** Moenjodaro. Pyroclastic blocklets of chalcedony from various localizations of the site (surface collection 1982-83).

**Fig. 29** Pattern of lump separation reconstructed for the fibrous varieties of chalcedony recovered on the MNSE Area (for explanation see text).



**Fig. 29**

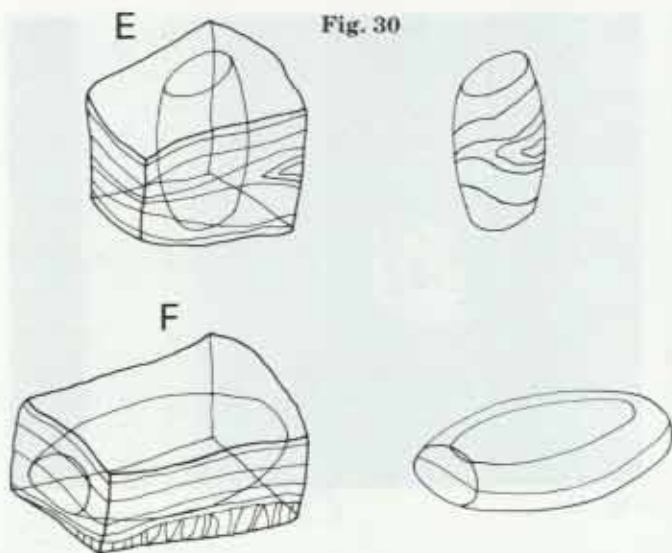


Fig. 30

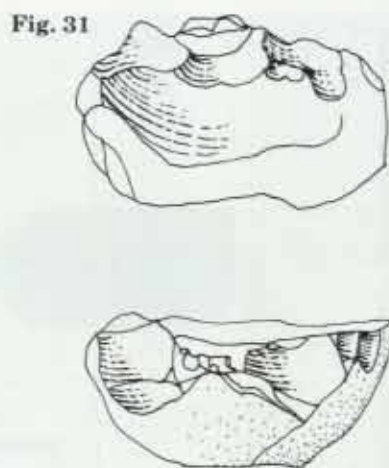


Fig. 31

Fig. 30 Types of orientation of beads according to the model described in the previous figure (for explanation see text).

Fig. 31 Moenjodaro. Fragment of chalcedony nodule with chipping traces recovered from the DK-G north dumps.

Fig. 32 Moenjodaro, MNSE Area. Chalcedony debitage in the form of chipped or broken alluvial pebbles.

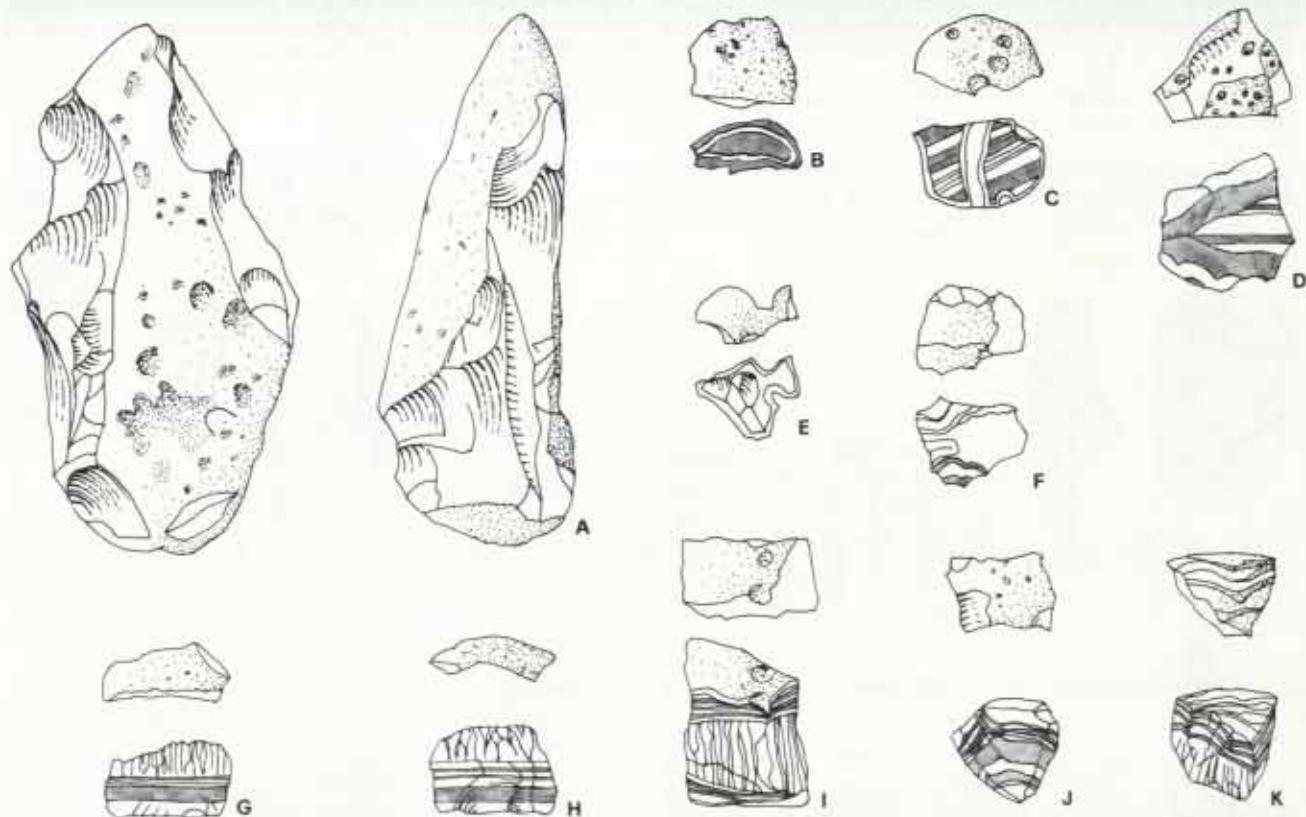


Fig. 32

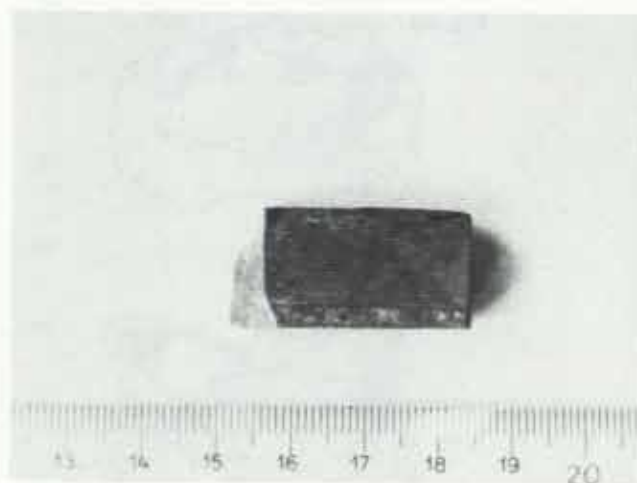


Fig. 33

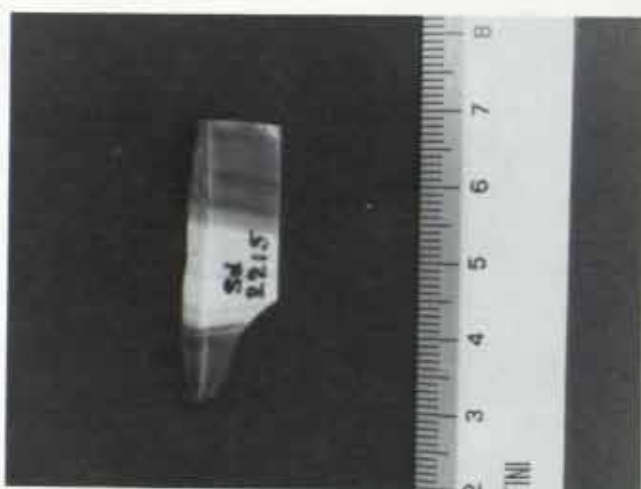


Fig. 34

Fig. 33 Moenjodaro, MNSE Area. Sawn blocklet in a greenish metamorphic stone from the surface collection.

Fig. 34 Moenjodaro. Chalcedony sawn element from SD Area, from the Moenjodaro Museum Reserve Collection.

Fig. 35 Moenjodaro. Lumps, rough-outs and blanks in serpentine. A, D, G, H, I from MNSE Area; the other items were recovered from different localizations of the site in the frame-work of the 1982-83 campaign of surface analysis.

Fig. 36 Moenjodaro, MNSE Area. Fibrous chalcedony rough-outs separated with a splitting technique (see the model of Figs. 30, 31) recovered from the surface.

Fig. 37 Moenjodaro, MNSE Area. Chalcedony rough-outs recovered from the surface.

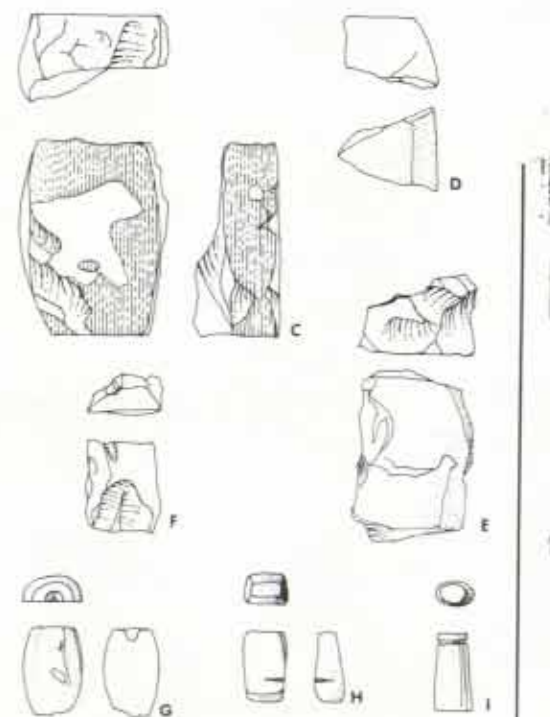
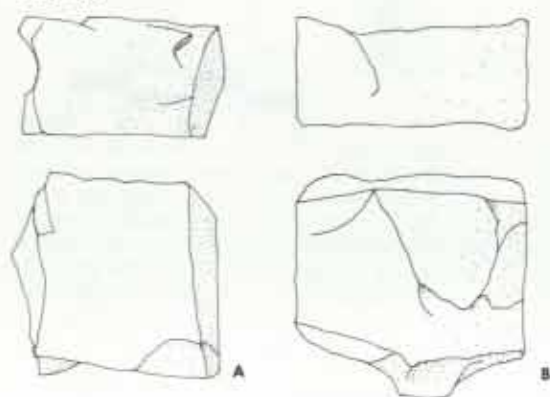


Fig. 35

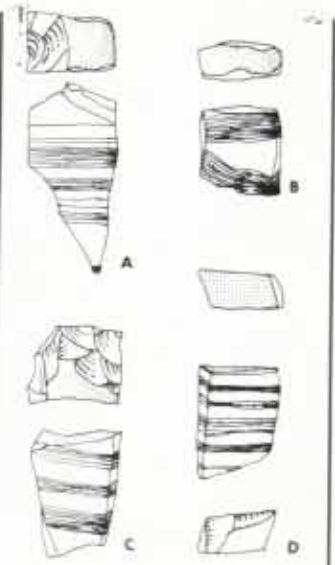


Fig. 36



Fig. 37



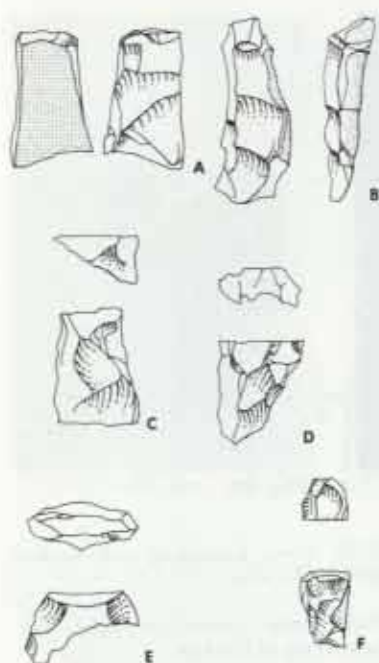


Fig. 38

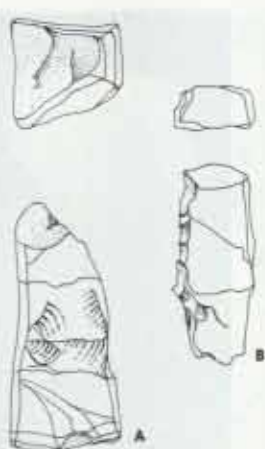


Fig. 39



Fig. 41

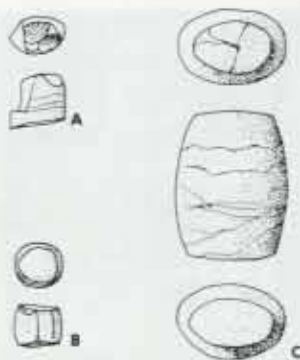


Fig. 41

**Fig. 38** Moenjodaro, MNSE Area. Chalcedony (A-E) and rock crystal rough-outs (F) recovered from the surface.

**Fig. 39** Moenjodaro, MNSE Area. Jasper and jasper-like rough-outs recovered from the surface.

**Fig. 40** Moenjodaro, MNSE Area. Chalcedony (A-E) and heliotrope (or bloodstone) rough-outs with partial polishing traces recovered from the surface.

**Fig. 41** Moenjodaro, MNSE Area. Chalcedony (A), Turquoise(?) (B) and heliotrope (C) bead-blanks from the surface of the site.

**Fig. 42** Moenjodaro, MNSE Area. Carnelian-agate (A-H, J-L) and moss-agate (I) rough-outs and bead-blanks from the surface of the site.



Fig. 42

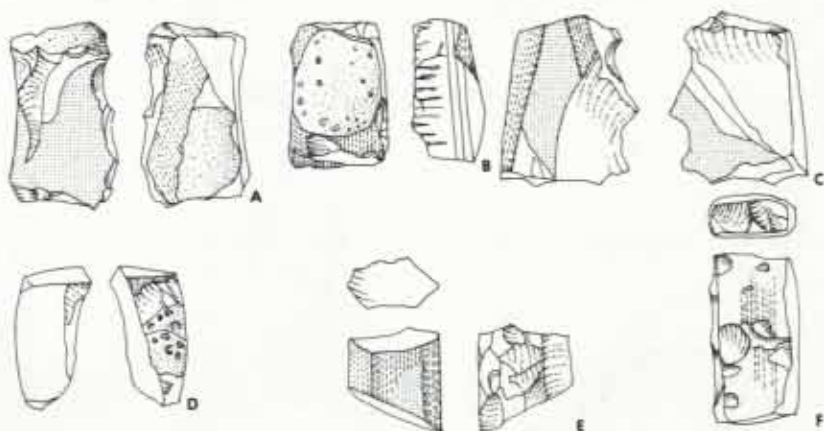


Fig. 40

Fig. 41



Fig. 43



Fig. 44



Fig. 45



Fig. 46

Fig. 43 Moenjodaro, MNSE Area. Complete and broken bead-blanks from the surface of the site.

Fig. 44 Moenjodaro, MNSE Area. Carnelian-agate "eye-stone" bead-blank from the surface of the site.

Fig. 45 Moenjodaro, MNSE Area. Turquoise(?) bead-blank from the surface of the site.

Fig. 46 Moenjodaro. Bead-smoothing quartzite tools from the HR Area and DK-B, -C Area dumps (surface collection 1982-83).

Fig. 47 Moenjodaro. Bead-smoothing quartzite tool from the HR Area dumps (surface collection 1982-83).

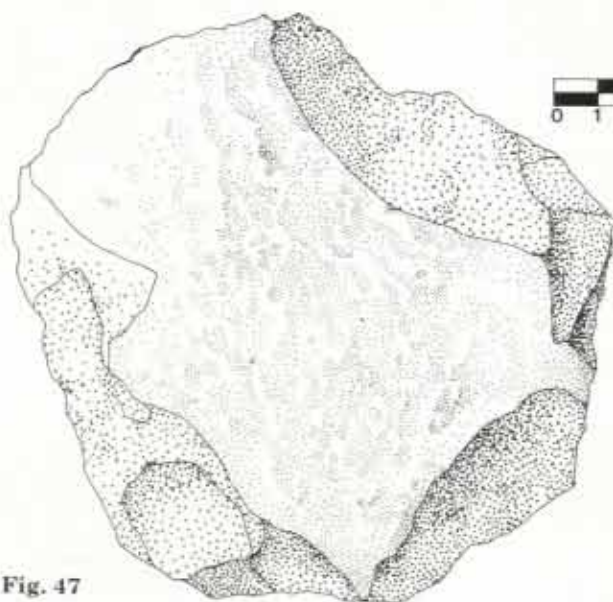
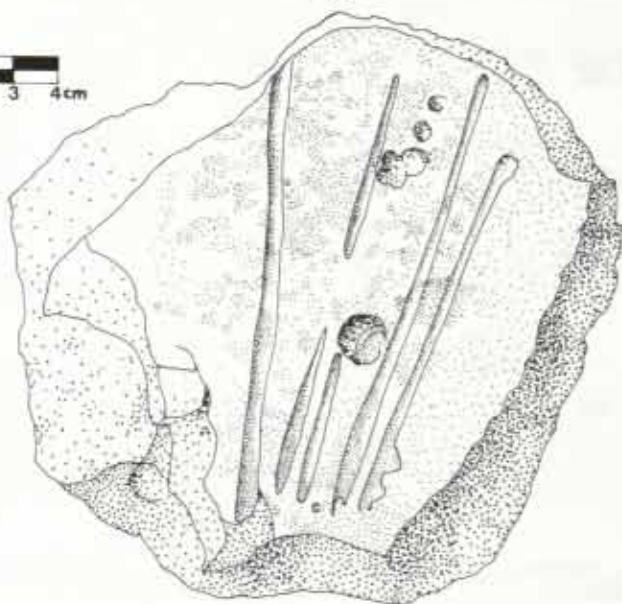


Fig. 47



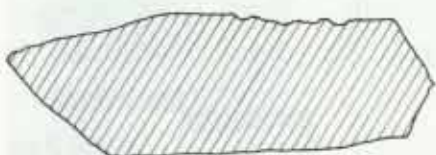
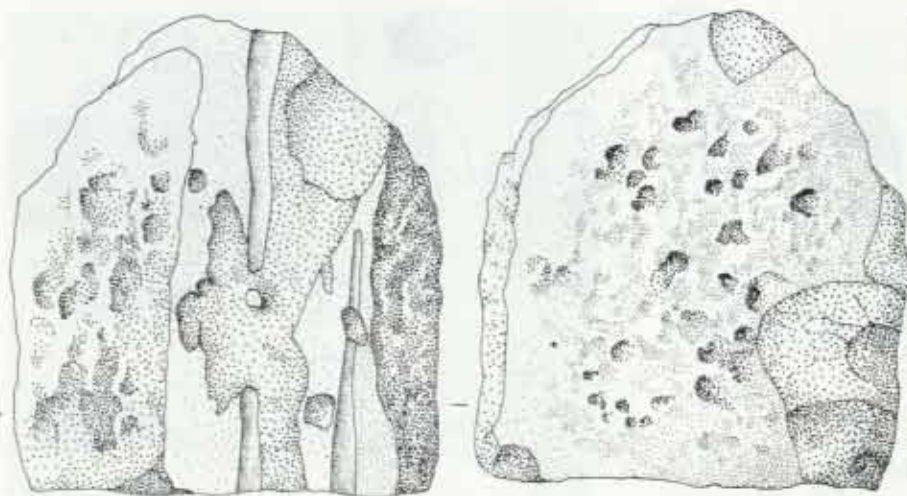


Fig. 48

Fig. 48 Moenjodaro. Bead-smoothing quartzite tool from the DK-B, -C Area dumps (surface collection 1982-83).

Figs. 49, 50, 51 Moenjodaro, MNSE Area. Sandstone tool with bead-smoothing traces recovered from the surface of the site.



Fig. 49



Fig. 50

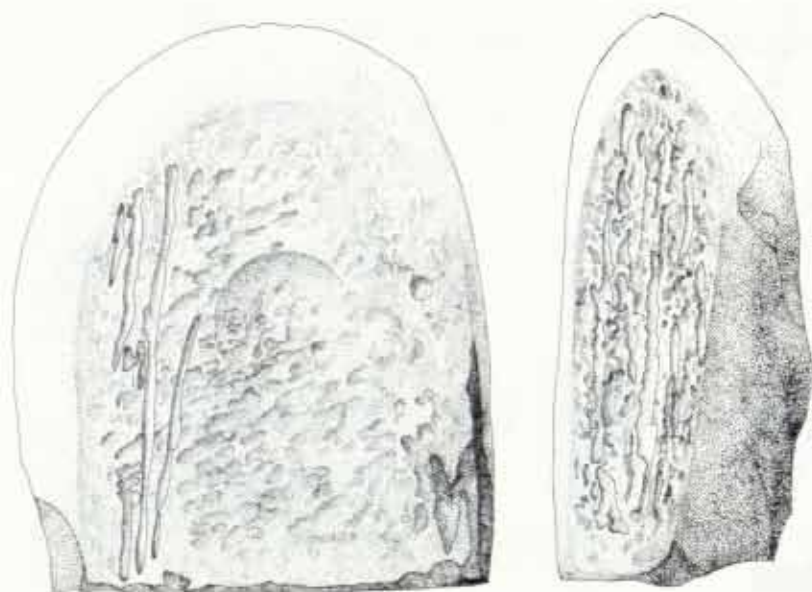


Fig. 51



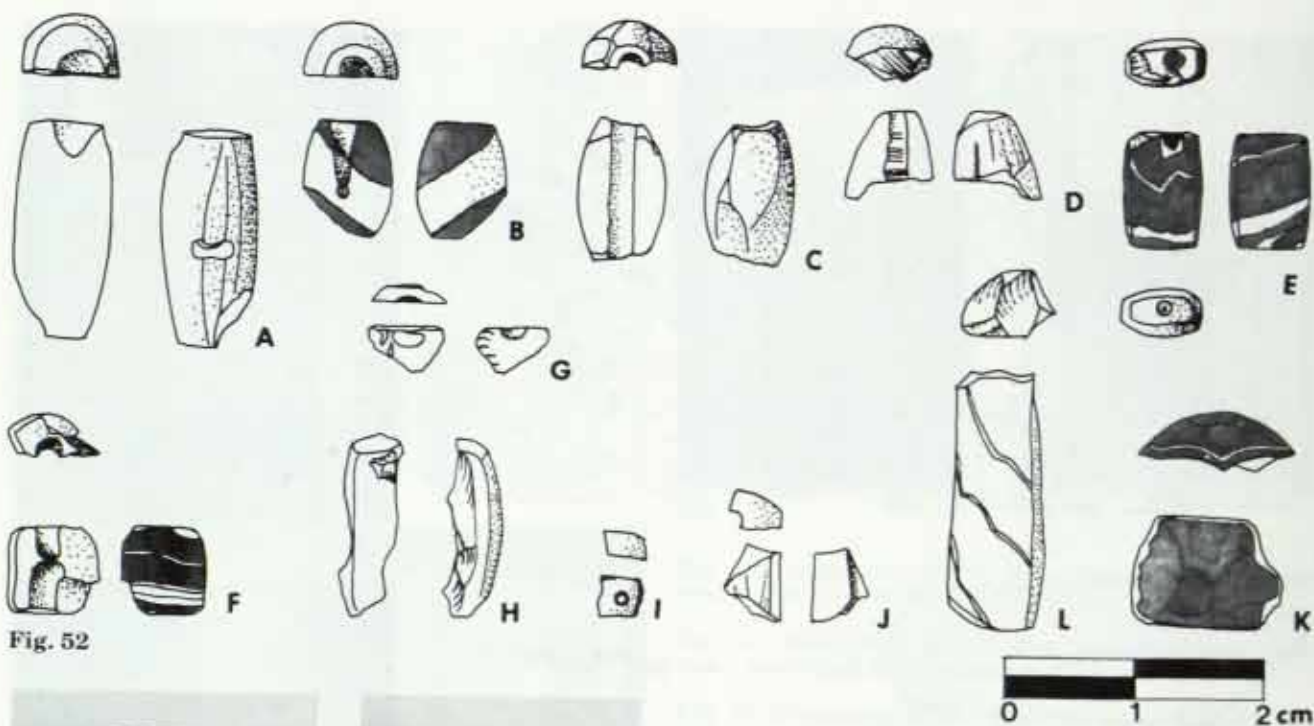


Fig. 52



Fig. 53



Fig. 54

Fig. 52 Moenjodaro, MNSE Area. Limestone (A, C, L), jasper (B, E), chalcedony (F, G, H, J, K) and lapis lazuli (I) bead-blanks broken in perforation from the surface collection.

Fig. 53 Moenjodaro, MNSE Area. Chalcedony bead-blank broken in perforation from the surface of the site.

Fig. 54 Moenjodaro, MNSE Area. Jasper bead-blank damaged and discarded during perforation from the surface of the site.

Fig. 55 Moenjodaro, MNSE Area. Chert drill-heads from the surface collection.

Fig. 56 Moenjodaro, MNSE Area. Phtanite debitage from the surface collection.

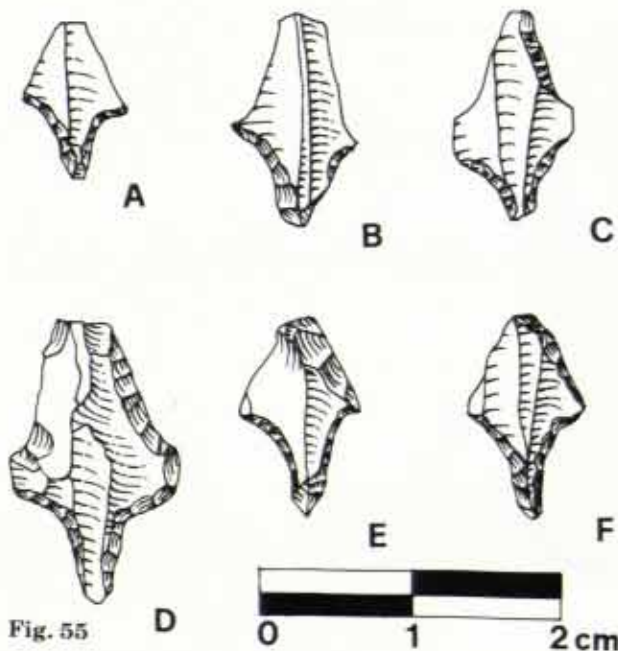


Fig. 55

Fig. 56





Fig. 57



Fig. 58



Fig. 59

Fig. 61



Fig. 62



Fig. 63

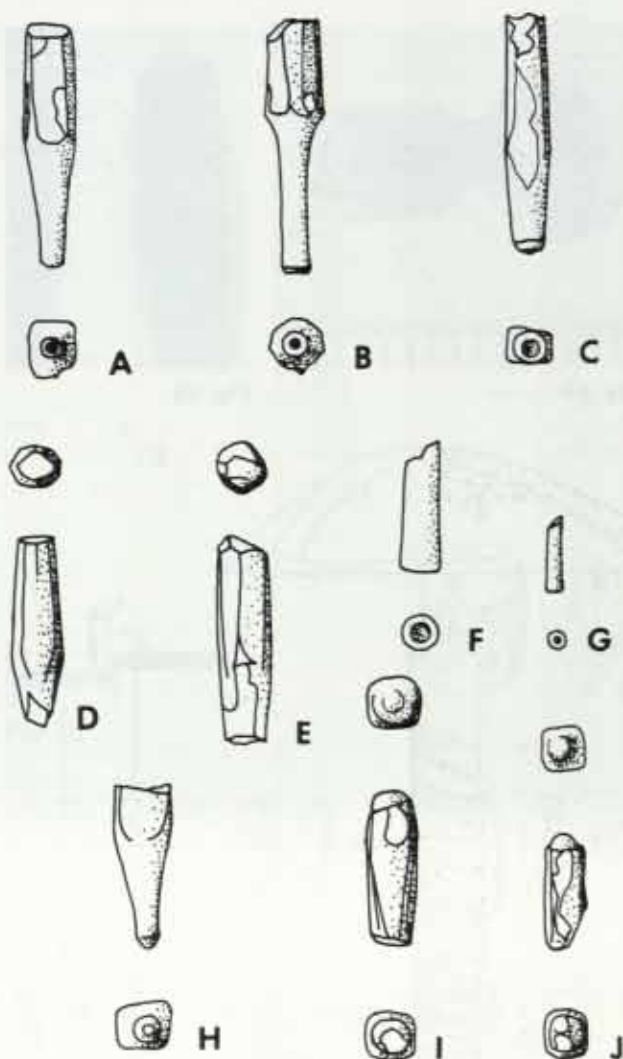


Fig. 60

Fig. 57 Moenjodaro, MNSE Area. Phtanite lump and chipped rough-outs from the surface collection.

Fig. 58 Moenjodaro, MNSE Area. Phtanite chipped rough-out from the surface collection.

Fig. 59 Moenjodaro, MNSE Area. Phtanite scale-like flakes detached in rough-out manufacture from the surface collection.

Fig. 60 Moenjodaro, MNSE Area. Phtanite drill-heads from the surface of the site.

Figs. 61-63 Moenjodaro, MNSE Area. Distal extremities of phtanite drill-heads from the surface of the site.



Fig. 64



Fig. 65

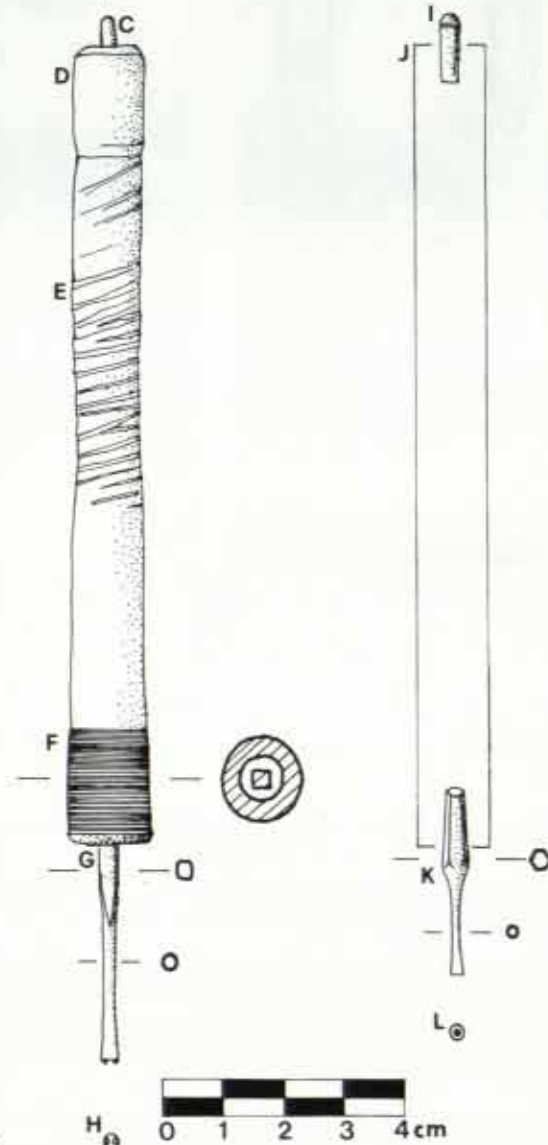
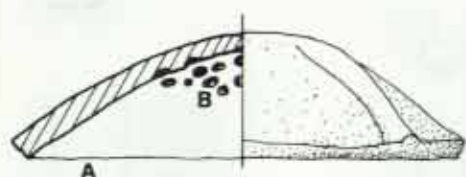


Fig. 66



Fig. 67



Fig. 68

**Figs. 64-65** Moenjodaro, MNSE Area. Particular of broken phtanite drill-heads re-utilized with function of upper drill pivot, recovered from the surface of the site.

**Fig. 66** Hypothetical of reconstruction of an Harappan drill based on the analogical comparisons with the drills nowadays used at Nagara (Gujarat, India): A. Coconut shell; B. Circular depressions left by the revolving pivot (C); C. Upper pivot in copper centered with the drill-head; E. Wooden haft (note the spirally-oriented wear traces left by the bow-string); F. Functional extremity of the drill-haft, covered with a thin coiling thread. The same thread (see the section) secures the drill-head in the haft hole; G. Drill-head manufactured out of an umbrella reed. The functional part of the tool is rounded before the point's utilization. H. Working end of the drill-head showing two diamond chips hammered into the tip. I. Broken phtanite drill re-utilized as upper pivot. Note the rounded wear trace on the tip. J. Analogical hypothesis on the dimensions of the wooden haft; K. Phtanite drill-head; L. Tip of the drill's working end showing the characteristic feature of the shallow hemispherical depression.

**Fig. 67** Moenjodaro. Hemispherical limestone cap studded with small pittings in the Moenjodaro Museum Reserve Collection (DK MM 653).

**Fig. 68** Moenjodaro. Close up of the pittings on the surface of the limestone cap reproduced in the preceding figure.

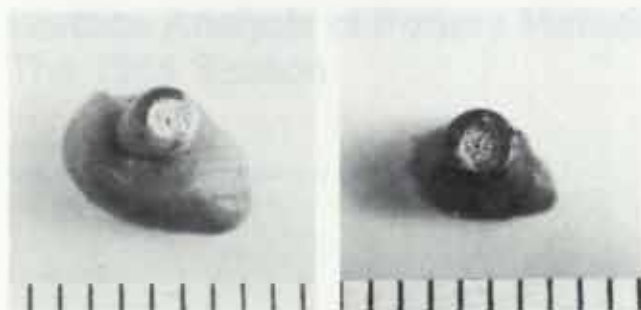


Fig. 69

Fig. 70

**Figs. 69, 70** Moenjodaro, MNSE Area. Particulars of the working end of phtanite drill-heads showing the distinctive shallow hemispherical depression.

**Fig. 71** Moenjodaro, MNSE Area. Unexploited lump (A) and broken chipped rough-outs (B, C) of banded chert for cube-shaped weight manufacture from the surface collection.

**Fig. 72** Moenjodaro, MNSE Area. Metamorphic rock splinters with polished or smoothed surface from the surface collection.

**Fig. 73** Moenjodaro, MNSE Area. Bronze/copper fragments from the surface of the site.

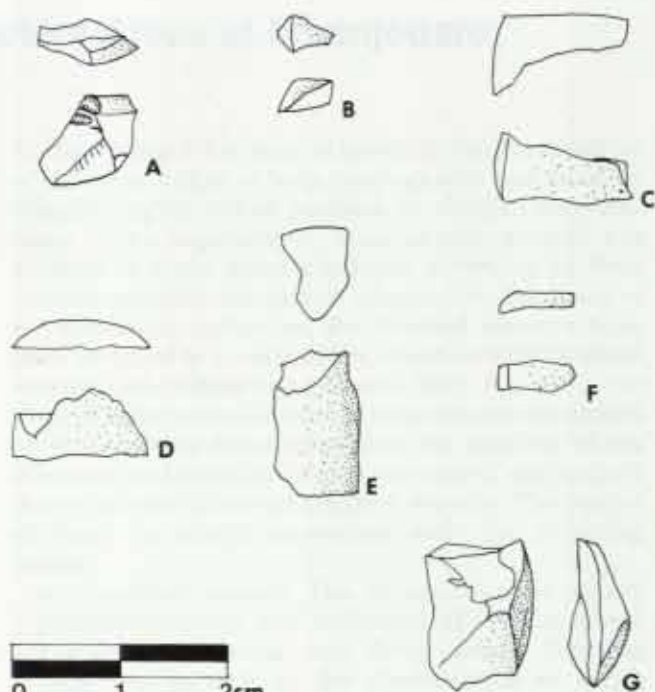


Fig. 72

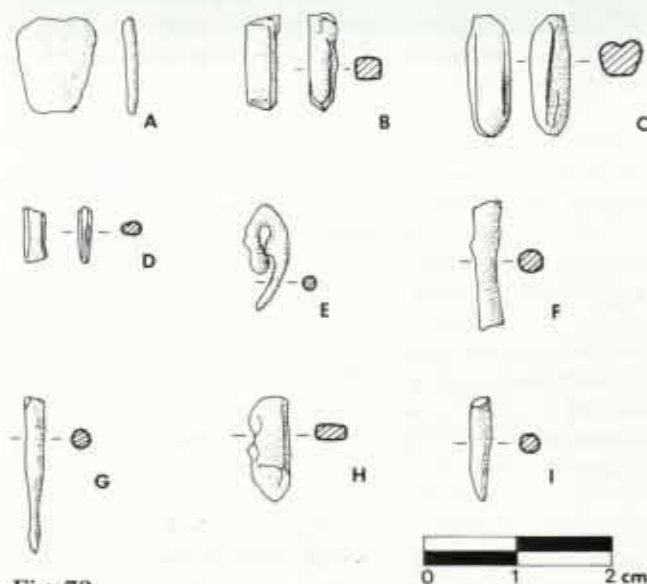


Fig. 73

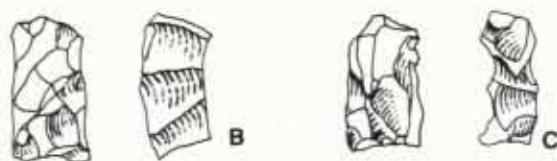
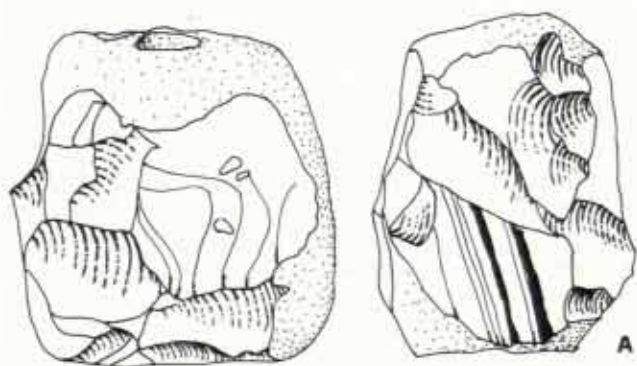
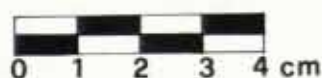


Fig. 71





# Surface Analysis of Pottery Manufacture Areas at Moenjodaro. The 1984 Season

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Ministerio dei Beni Culturali e Ambientali,  
Rome

The aim of this paper is to outline aspects and first results of the investigation of the craft industry of pottery-making begun during the 1984 campaign at Moenjodaro as part of the broader Surface Evaluation Programme directed by M. Jansen and M. Tosi.<sup>1</sup>

This first investigation was designed to carry out observations, form hypotheses and to elaborate a strategy on which to base a future series of verification procedures; the present paper should be seen in this perspective. As some results have already been published (Pracchia et al. 1985), the emphasis is here on the operative aspects of the research with particular reference to stratigraphic and artefactual elements.

Up till now, the only available information we had on this manufacturing process at Moenjodaro was drawn from the earlier excavators' reports (Marshall 1931, Mackay 1938) where the references pertinent to a surface evaluation only deal with summary descriptions of recovered kilns and their location (Pracchia et al. 1985). Also almost totally absent from these reports are indications regarding the functional purpose of the relevant structure and the whole body of artefactual evidence that could help to define it.

In the course of the years of research, the examination of the huge heaps of both typologically and distributionally highly varied residues of vitrified clay that cover large expanses of unexcavated ground has resulted in their being classified according to their various possible functional origins. On the basis of the dominant indicators, the vitrified remains have been assigned to nodule floors, stoneware-firing waste spreads and pottery-firing dumps (*ibid.*: Fig. 1).

The 1984 analysis conducted on these remains was based on the working hypotheses that the position of the kilns can be determined by the presence of particularly dense concentrations of vitrified wasters. The project at hand is chiefly concerned with the following issues:

a. Locational aspects. The delimitation of pottery production areas, the definition of the functional variability (forming and firing areas, dumping locations) as well as the identification of single kilns, with the object of gaining information on the degree of labour organization (Tosi 1984, Vidale 1983, Bondioli et al. 1984).

b. Characteristics of the manufacturing processes. The form, nature and function of facilities and tools (from the morphology of kilns to the identification of specialized instruments); technological aspects of the transformational sequence (firing parameters, different stages of the process); the type and amount of products with specific reference to the specialization level of vessel production.

c. Chronology. The relative and absolute components of the exposed topsoil with the object of calculating the overall reading of surface evidence.

The evaluation of post-depositional events (i.e. the transformation dynamics affecting installations after abandonment) assumes particular relevance in this project, as it does for other manufacturing processes. In fact, it is compulsory to recognize these dynamics if we are to retrace the path leading from the present evidence back to its genetic roots. The investigation was conducted in three different areas, chosen (other than for the presence of vitrified remains) according to their geomorphological profiles: plateaus, hummocks, depressions etc. In all three cases, the relevant areas were mapped and stripped with a vacuum cleaner in units of 0.25 m<sup>2</sup> to a depth of about 0.20 m.

## Area south of DK-B-C (2820-1395)

The first of the tested squares, provisionally referred to as KAI, is located on top of one of the areas not altered by previous excavation activity. The deciding factor in the choice was to complete isolation of the

wasters with respect to the surrounding areas. The homogeneity of slags and potsherds on the surface, scattered over about 6 m<sup>2</sup> and decreasing in size and density from a central point, and the location of a very slight depression on top of the hummock would seem to indicate, with a high degree of probability, the presence of a kiln still in place, particularly in view of the fact that the level summit area of the site usually presents the most unsatisfactory conditions for a surface reading due to high frequentation and scarcity of erosive action. The map (Fig. 1) drawn up on the basis of the provisional operative morphological typology used previous year in the Moneer SE area (Bondioli et al. 1984: Fig. 6) reveals a rather select number of slags. Of the twelve types identified (Pracchia et al. 1985, Tab. 3), only three are present: overfired bricks, fracture surfaces and melted drops. These are normally found at the bottom of the lower kiln chamber, generally after the melting of the inner structural components of the kiln.

The first cleaning operation was undertaken to a depth of about 20 cms (Fig. 2) in order to compare the surface picture with the buried situation. The impression of homogeneity and the decreasing density of wasters noted on the surface corresponded in this case with the subsoil. The graphic representations (Figs. 3, 4) show the behaviour of the melted drops, expressed in absolute numerical frequency decreasing progressively from a central point. The same homogeneity was noted in the size of the slags, up to 5 cms approximately.

In the centre of the stripped area a row of decayed bricks was visible, arranged triangularly around an ash layer and with a filling containing fragmentary vessels (Fig. 5). The identified layers were then removed to avoid them decaying completely due to their proximity with the surface and also to gain a coherent picture of the evidence briefly described below.

#### Stratigraphic units of the kiln south of DK-B-C (Figs. 5, 6)

Sediment of silty-ash (2) presumably produced during the abandonment of the area and partially disturbed on the top by later erosion. The drops (3) distributed on the surface spread from this point.

Sediment produced by the disintegration of vessels shortly after abandonment and preserved in the kiln in fragmentary condition. Their state of preservation depends on the degree of protection offered by the sediment and on the proximity with the surface (Fig. 7). The only find that suggests their presence in the chamber during the last firing is the mouth of a jar (Fig. 8), highly vitrified on the side facing the ash layer (5). The position of (3) on the contrary, arranged between the stoke hole and the fire remains, indicates that this is not the original load of the kiln. On the top of the layer, a negative interface produced by later

erosion, a chaff-tempered clay object (Fig. 9) with a rounded structural side could be related to the original closing of the stoke hole.<sup>3</sup> The significant indications here are its dimensions, the overfiring of only one of the two faces, the absence of traces of applications serving as a lining on the walls, the lack of a plaster lining on the inner wall and a piece of the same material of the same thickness positioned between two bricks at the entrance. The pottery and related stratum is in direct contact with the lower layer. Even though this pottery can not be described definitively as a product of the kiln, the direct contact with the lower stratum indicates the pertinence of the vessels for the dating of the structure. The pottery found in layer (3) belongs to the late period of the settlement (Fig. 10) even though the merely partial control we have over the pottery sequence renders a satisfactory dating difficult to achieve.

(4) Thin deposit of melted drops produced during the last firing and buried under a few millimeters of the ash produced by the same firing (5).

(5) Ash layer containing immediately below its surface a carpet of melted drops. The edge of the stratum was damaged by erosion in recent times, and this caused the dispersion of drops noted on the surface.<sup>3</sup>

(6) Inner bottom of the kiln belonging to the last firing. It is composed of very compact clayish silt with traces of burnishing near the corners of the back side of the structure.

(7) Silt produced after the structure was abandoned. It covers the structure and is eroded on the top. Reddish in colour, it contains very sporadic small fragments of pottery and other artefacts.

(8) Kiln, see description below.

(9) Layer very similar to (7) but more compact and containing a high percentage of inclusions, mainly broken bricks. This could be a filling surrounding the kiln walls and this impression is confirmed by the contact, noted some centimeters south of the structure, between this stratum and (7) covering it. The filling surrounding the kiln corresponds to the ditch normally enclosing, in up-draught kilns, a firing chamber.

#### The Kiln (Figs. 5, 6)

Triangular in plan, the kiln is delimited by a single row of rectangular bricks belonging to later phases (Jansen, pers. comm.) which, judging by their fragmentary conditions, were probably re-utilized from other structures. The back of the kiln is re-enforced by four bricks lying side by side lengthways. On the sides of this pseudo-pillar are two recesses with vitrified surfaces like the inner walls which seem to indicate the original presence of two flues or chimneys. Furthermore, on the back of the kiln two large blocks of clay melted into place indicate the higher degree of heating of the

chamber at this point as would be expected near the chimney.<sup>4</sup>

The kiln, although comparable in shape with the examples known from Harappa (*Vats* 1940: 470-71) could, due to a series of details, belong to a horizontal type and not to the common up-draught structures normally met within the Indus Civilization. Factors which point towards this interpretational direction are the complete absence of vitrified material belonging to a middle floor and the absence of a central pillar or a wall tongue to sustain it. Other characteristics, if we compare this kiln with others of the postulated type, are the concave fire-place immediately behind the entrance, the inclined inner profile and the flues at the back.<sup>5</sup> The kiln, as already mentioned, seems to be surrounded by a filling (layer (9)).

#### Area south-east of A.A. 27 (2870-1030)

The area provisionally referred to as KAM is located south of the long hummock running eastwards from the excavated area of HR, not very far from the dam and the new channel surrounding the site. In a depression caused by recent earth-removing activities, a circular formation of about 3 m<sup>2</sup> of vitrified clay slugs was visible and it was easily recognizable as a kiln still in place (*Fig. 11*). In this case it was sufficient to clean the surface to a depth of no more than 10-15 cms in order to expose the complete perimeter of the structure. The information we had was of hardly any use in the evaluation of post-depositional events and the cleaning was executed in order to record the endangered structure and to obtain information on its characteristics.

#### The Kiln (*Figs. 12, 13*)

The exposed portion of the kiln belongs to the bottom of a firing chamber (the upper part probably disappeared with the recent lowering of the original level) measuring about 200 x 1,70 cms; the stoke hole is about 60 x 70 cms and is orientated south-east. The perimeter is constituted of a row of bricks, laid horizontally end to end. In the centre of it, in the same axis as the stoke hole, the tongue wall originally supporting the grid is visible. The inner wall is plastered with a chaff-tempered clay lining. At certain points at the back of the chamber, concentric lines indicate the possible restoration of the structure, alternatively they were simply formed by the collapse of the upper part. The bottom of the kiln is partially covered by a thin layer of greenish melted clay produced during firing. This should represent its final coating; as observed on the inner wall, (*Fig. 12*) the vitrified wall linings extend vertically under the melted

clay floor indicating the possible existence of previous levels of activity.<sup>6</sup> On the basis of normally observed requirements for preserving heat, the firing chamber must have originally been embedded in or surrounded by an earthen filling; an erect structure of these dimensions would be statically impossible with such thin walls. This type of kiln is comparable to the others discovered by the earlier excavators (*Marshall* 1931: 102, Pl. LV16; 225-6, Pl. LVIIIb) and more generally to others known from the Indus Civilization (*Balakot, Dales* 1974: 10, *Fig. 7*; *Lothal, Rao* 1979: 83, 118, *Fig. 11, 12*; Pls. XXXVIb, XCIa, b). In this case the chronological and functional classification is problematic due to the scarcity of associated finds. The use of the kiln for firing pottery can only be concluded empirically and the few overfired clay specimens can be associated with it only because they are superimposed, which does not favour any well-founded chronology. For the moment we are unable to decide whether the isolation of the structure has been brought about artificially by recent activities or not.

#### A.A. 32 (2250-1845)

The third survey was carried out within the larger area usually attributed to pottery manufacture (*Bondioli et al.* 1984: 29). The area lies to the north of DK-G excavation where Mackay found at least six kilns belonging to the town's last period (*Mackay* 1938: 6). The presence of kilns among the partially abandoned houses of previous periods, the clay waster filling of building trenches and the diffusion of slugs and pottery remains on the surfaces around the excavation have been traditionally seen as indications of a later functional change from a residential to a craft area. The slag concentration chosen for testing crowns the top of a small hummock and, like that south of DK-B-C, the elements forming it decreased in frequency and size from a central point (*Fig. 14*). As with the other case a map was drawn up and the surface was stripped to a depth of about 20 cms (*Fig. 15*). The removed deposit was composed of thin superimposed strata, distinguishable only by a slight chromatic variation in the silt matrix. Layers (2), (3) and (4) were characterized by a high concentration of inclusions such as fragmentary bricks, slugs, overfired potsherds and, occasionally, bones. Layer (11) was mainly composed of broken bricks (*Fig. 16*).

All the tested deposit from the surface to a depth of 2-5 cms had been homogenized by erosive action and weathering. There was a marked contrast between the quantities of wasters visible on the surface and contained in the deposit below it. Here the frequency of slugs was in fact very low compared to the high concentration noted on the surface. The post-depositional process leading to the observed evidence has been empirically reconstructed as follows.

### Formation of slag carpets on the surface (Fig. 17)

The surface appears to be a negative interface produced by water erosion and eolic deflation on the refuse deposits forming the upper levels of the hummock (Fig. 17a). The combined actions of these agents had progressively lowered the deposit by removing the silt but leaving the heavier inclusions, among them slags and overfired potsherds (Fig. 17b). The exposed slags have been progressively broken by thermal dilation combined with salt efflorescence (Fig. 17c). The non-overfired inclusions such as potsherds and bricks are embedded in a sediment which was gradually carried away by erosion. Sometimes, crumbled slags are found trapped in eroded gullies. In any case, the result is a concentration of wasters and rare traces of barely identifiable clay remains. Their regular and concentrated distribution is, in this case, more apparent than real and is confined to the surface as their presence in the subsoil is extremely random (Fig. 17d).

### The exposed horizontal stratigraphy in A.A. 32

Under the refuse layers (Fig. 18) lie the traces of some kind of structures, evidenced by scantiest remains. On a subhorizontal layer (7), a residual row of bricks is visible (6). A mud clay floor (5) and a trodden plain (13) composed of densely compacted sediment are the other elements associated with the decaying or the robbery of bricks by the collapsed stratum (11). Layer (14) does not present traces of wasters arising from firing activity and the same applies to all the other horizontal stratigraphic units. The general impression gained is, judging by the excavation data, that of a badly damaged habitation level used in a later phase as a dump area.

### Observations on phenomenological characteristics of surface waster concentrations.

Although the distribution observed south of DK-B-C and here in A.A. 32 appears very similar, a closer inspection of the quantitative and qualitative aspects of overfired clay specimens reveals some differences. In the case of melted drops, for example, their distribution (Fig. 19) is totally different from that of DK-B-C (Fig. 14). Although the two diagrams are not strictly comparable as one is expressed in numeric values and the other in ponderal values, they are, however, evidence of the difference in terms of presence/absence and increase/decrease as against random distribution. The same impression of stochastic behaviour is obtained from an evaluation of the ponderal values of slags found to a depth of less than about 5 cms (Fig. 20).

### Examination of single residues from A.A. 32

The careful observation of selected slags provided information concerning the construction characteristics of kilns and types of products present in the area. In the case of one example (Figs. 21, 22) its present condition may have been caused by a traumatic event during firing.<sup>7</sup> It is part of a grate composed of small bricks on top of which the original floor of the firing chamber, plastered with a chaff-tempered clay lining, was sealed by melting vessels. Another specimen (Fig. 23) shows a pile of melted beakers in contact with some nodules whose function has not been precisely defined (Pracchia et al. 1985, see note 4).<sup>8</sup> In this specimen the cohering elements can be read in two ways: as a product together with the beakers or as setters or distancers,<sup>9</sup> to support the vessels and to protect them from smoke effects.<sup>10</sup>

The high occurrence of potsherds in the refuse layers could give us some idea of types of kiln-produced pottery and of the ceramic range of the late period. Five of the most common shapes encountered are listed on Fig. 24 and the percentage value of their occurrence is expressed in the relative diagram. The illustrated sample, about 200 fragments, is too small and the area too restricted to enable us to hazard any inference on the frequency of types, but the evidenced ratio between beakers and jars roughly confirms the impression gained by simply observing the surface.

### Conclusions

The observations reported in this paper represent the fruit of the first study during the 1984 season of pottery-manufacture at Moenjodaro. The analysis of the complex phenomenology of vitrified remains furnished a set of working tools for use in the investigation. The first operational instrument was the morphological typology of overfired slags empirically organized to control, as closely as possible, the variability of the topsoil subjected to analysis. For this purpose the various specimens have been sorted on the basis of observed primary situations and attributed to various parts of kilns with different degrees of vitrification (the list of identified AICA<sup>11</sup> and the operative typology are shown in Pracchia et al. 1985: Tabs. 2, 3).

Compared to the large amount of available evidence the examined samples are still too few to allow us to hazard a general picture of the nature of pottery production. The first observations made in the field together with the data made available from the excavations of the first half of the century seem to confirm the existence, in the late period, of two different types of labour organization evidenced by differences in kiln construction and in their residual products. Isolated structures like the two observed during the '84

campaign or those found during the excavations in residential areas (Marshall 1931: 225-6, Pl. LVIIIb), compared with the finds of clusters of kilns and enormous amounts of wasters, led us to think of domestic versus industrial production (Fig. 25). On the other hand, our partial knowledge of the Harappan pottery chronological sequence and the indefinite nature of the stratigraphic evidence from the earlier locations does not fully justify the presumed contemporaneity of the two systems. It is therefore difficult to decide whether the six kilns discovered by Mackay were in operation together or whether this impression arises simply because they generally belong to late levels.

Exploration in various eastern settlements has revealed, in conjunction with periods of considerable urban development, industrial areas for pottery manufacture crowded with a high number of kilns.<sup>12</sup> In regard to the six kilns it is still doubtful — at least on the basis of observations in A.A. 32 — that a major factor in the hypothetical mass production is the high resistance of vitrified clay residues to natural and anthropic degrading action. The impression (still to be confirmed) of the variability of the pottery heaps in dump areas could be, however, for the type of production, just that made by the late period of the settlement. For clues to the labour organization of previous periods such as that hypothesized for brick production (Pracchia et al. s.d.) the possible industrial quarters satisfying the demands of such an urban center have to be sought far from the actual perimeter of the compound because of the strong atmospheric and thermic pollution produced by the firing installations.<sup>13</sup> Whatever the degree of accuracy in the analyses and the possible inferences we can draw, the picture that begins to emerge from the surface evaluation of pottery manufacture areas seems to relate mainly to the later phases of the settlement. On the other hand, we have few possibilities of detecting areas belonging to previous periods, as in the case of other types of manufacture, because of the apparent lack of original evidence within the present visible perimeter of the town. We shall address our future research to this aspect, which is particularly meaningful for the whole picture of craft production at Moenjodaro obtainable from the surface record.

## Footnotes

- 1 All methodological statements in the present work are to be referred to the general aims of the project expressed in Bondioli et al. 1984 and refined by the authors across the experiences of the field activity at Moenjodaro and other sites, mainly in the Iranian plateau. We will avoid here, except for strictly technical topics, continuous citations of the mentioned work, starting point of the whole programme regarding surface evaluation.
- 2 As observed directly in the Lal Shah kilns at Mehrgarh (Pracchia s.d.) and in the following example, the chaff-tempered clay lining is frequently employed to plaster the inner walls of the firing chamber in up-draught kilns.
- 3 This particular example demonstrates the stratigraphical paradox of the same layer (5), covering and being covered by another layer.
- 4 The morphology of these two slags is different from that observed on the surface.
- 5 Comparable structural types have been encountered, but very distant in time and space (Barnard 1976: 22, figs. 14-15); the horizontal shape and the relative draught of hot air from the entrance directly to the chimney at the back side is a device that enables for increased temperature and, in case of pottery making, the optimization of the fuel used for heating.
- 6 It is possible, as observed during the '85 season at Mehrgarh in one of the excavated Lal Shah kilns, that in some cases the lower floor grows in time according to different restorations.
- 7 It can be supposed that parts of slags and overfired pottery fragments are normally produced during the firing and thrown on refuse areas after periodical cleaning. Sometimes, as in this case, the firing causes accidents involving the whole kiln.
- 8 The only established function is a filling under the pavements of later buildings (Mackay 1938: 85). The enormous amounts of such nodules in many parts of the site surface, however, suggest some other unidentified use.
- 9 The use at Moenjodaro of devices to support the vessel during firing is documented in a possible saggar (Halim-Vidale 1984). In this case terracotta bangles were used.
- 10 Shepard 1976: 92
- 11 Archaeological Indicators of Craft Activity following Tosi's definition (Bondioli et al. 1984).
- 12 Fifty kilns from tepe Rud-i Biyaban 2 (Tosi 1984: 42); sixty from Altyn Depe (Kohl 1984: 127). The first sounding at Lal Shah hill near Mehrgarh revealed six different kilns clustered within an area of about 50 m<sup>2</sup> (Pracchia, Excavations of a Bronze Age Manufacturing Area; in press)
- 13 For examples of peripheric industrial area cf. Mundigak, Nuzi, Altyn Depe, Outch Depe (citing Delcroix-Huot 1972: 81), tepe Dash (Biscione et al 1975: 40-41; Tosi 1984: 42, fig. 57; Mariani 1984) and Lal Shah-Mehrgarh (Pracchia s.d.). For Chanhu daro Mackay (Mackay 1943: 70) noted that: "No kilns that could have been used for pottery have as yet come to light at Chanhu-daro, probably because they were placed well outside the city."

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Fig. 1 Spread of overfired clay specimens in the area south of DK-B-C.

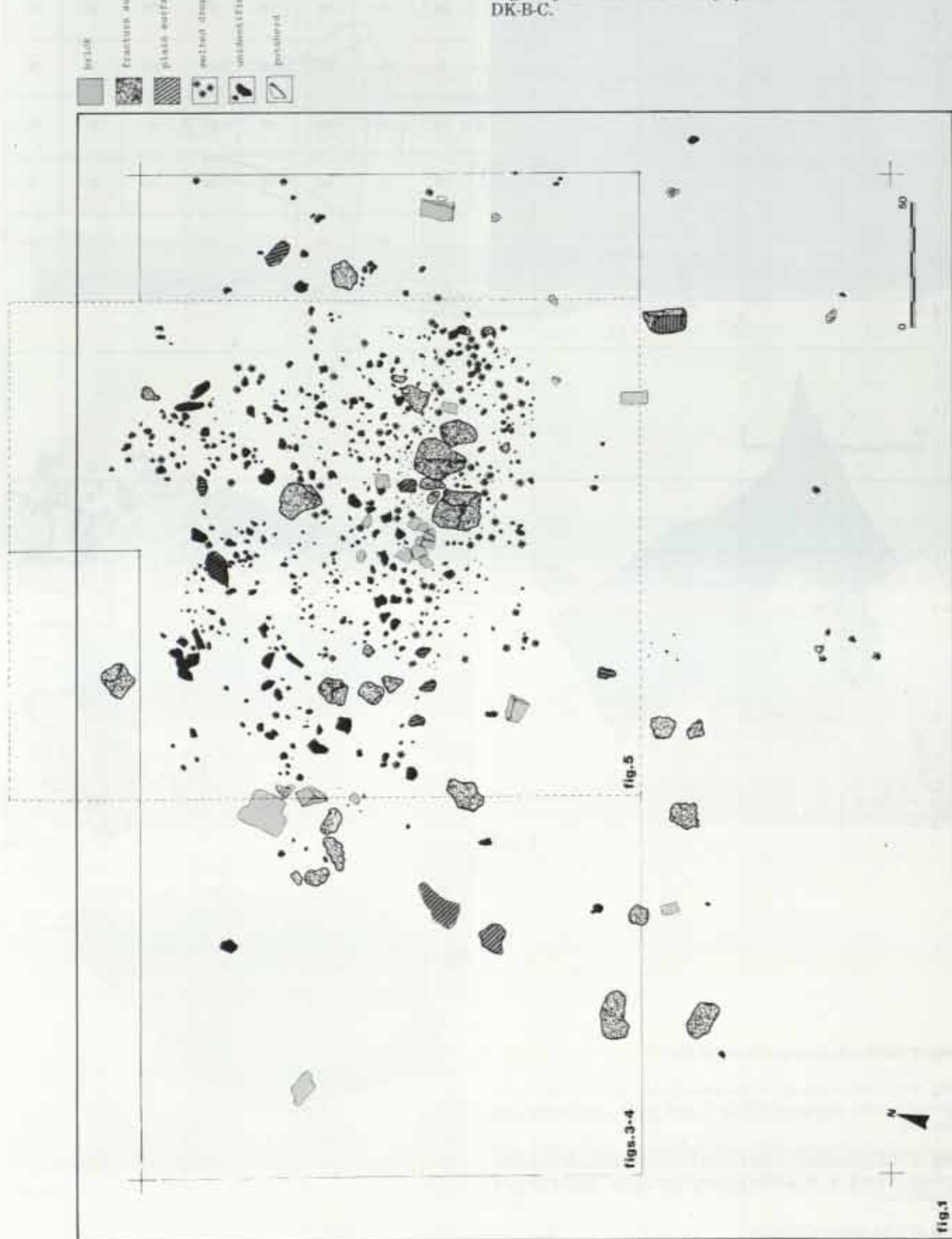




Fig. 2

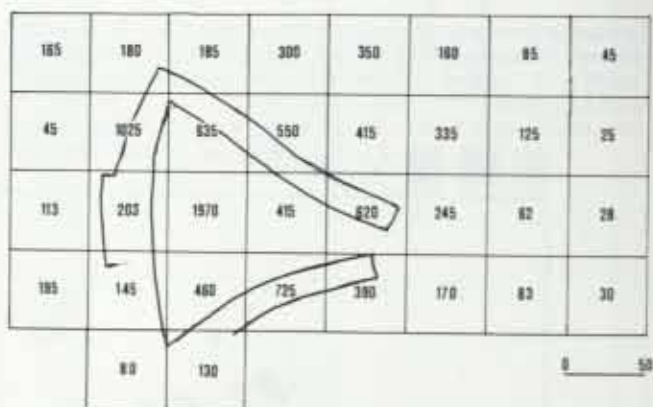


Fig. 3

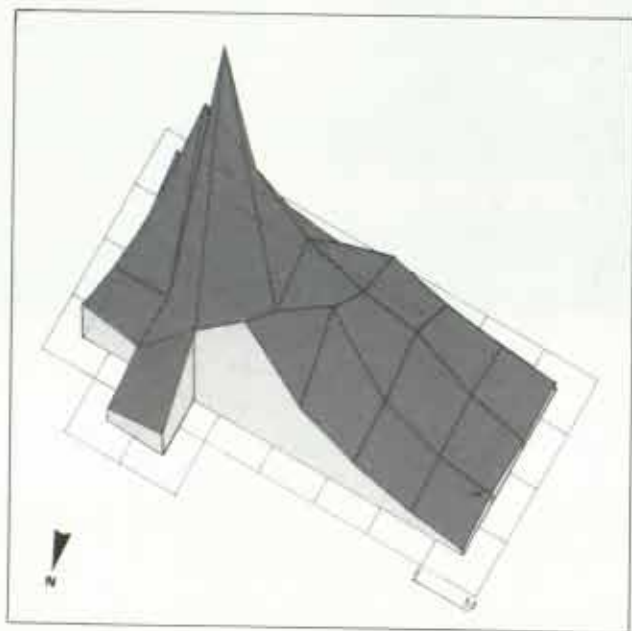


Fig. 4

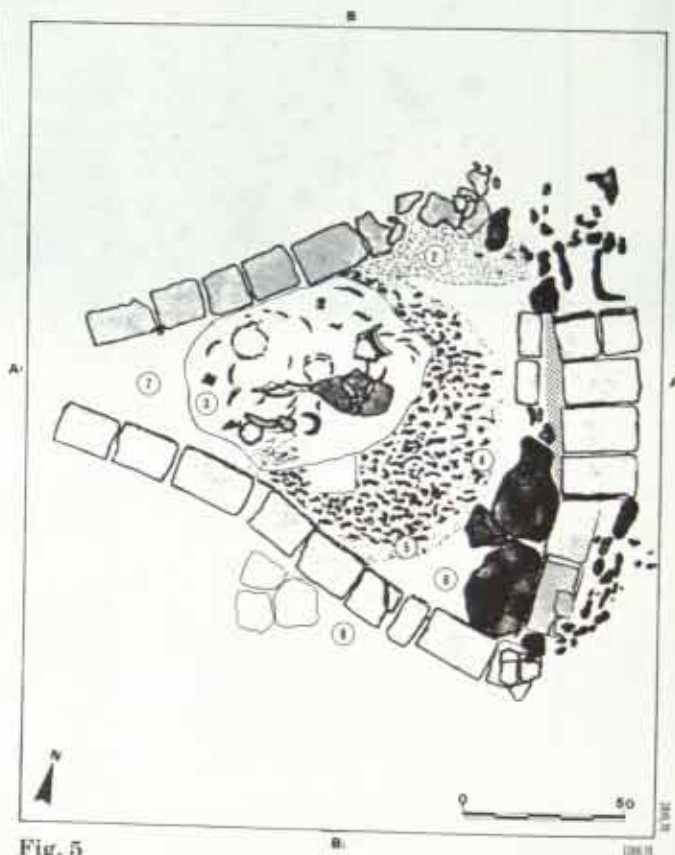


Fig. 5

Fig. 2 First stripping south of DK-B-C.

Fig. 3 Absolute numeric value of melted drops recovered from sampled area south of DK-B-C and their localization on the grid.

Fig. 4 The quantitative behaviour of melted drops in absolute values shows a progressive decrease from the point of irradiation.

Fig. 5 Kiln south of DK-B-C.

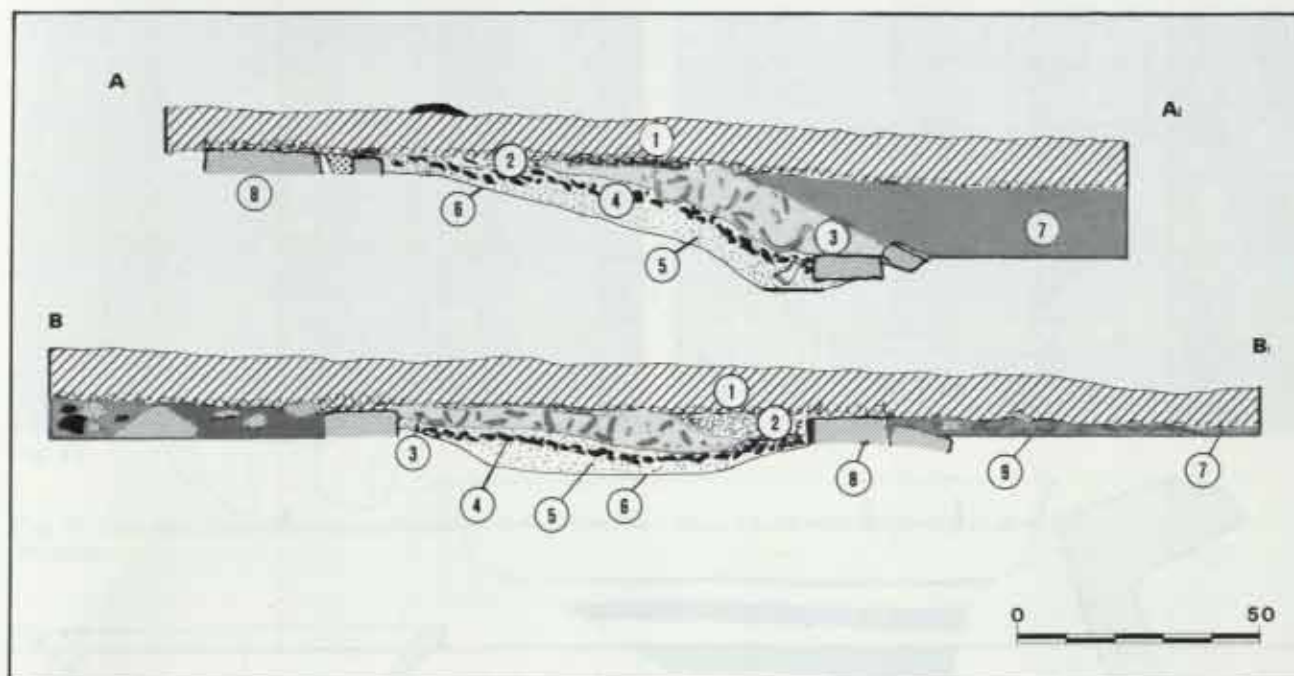


Fig. 6



Fig. 7



Fig. 8



Fig. 9

Fig. 6 Sections of tested area south of DK-B-C.

Fig. 7 Small pot progressively decayed towards the soil surface.

Fig. 8 Fragmentary jar gradually vitrified (from right to left).

Fig. 9 Chaff-tempered clay fragment.

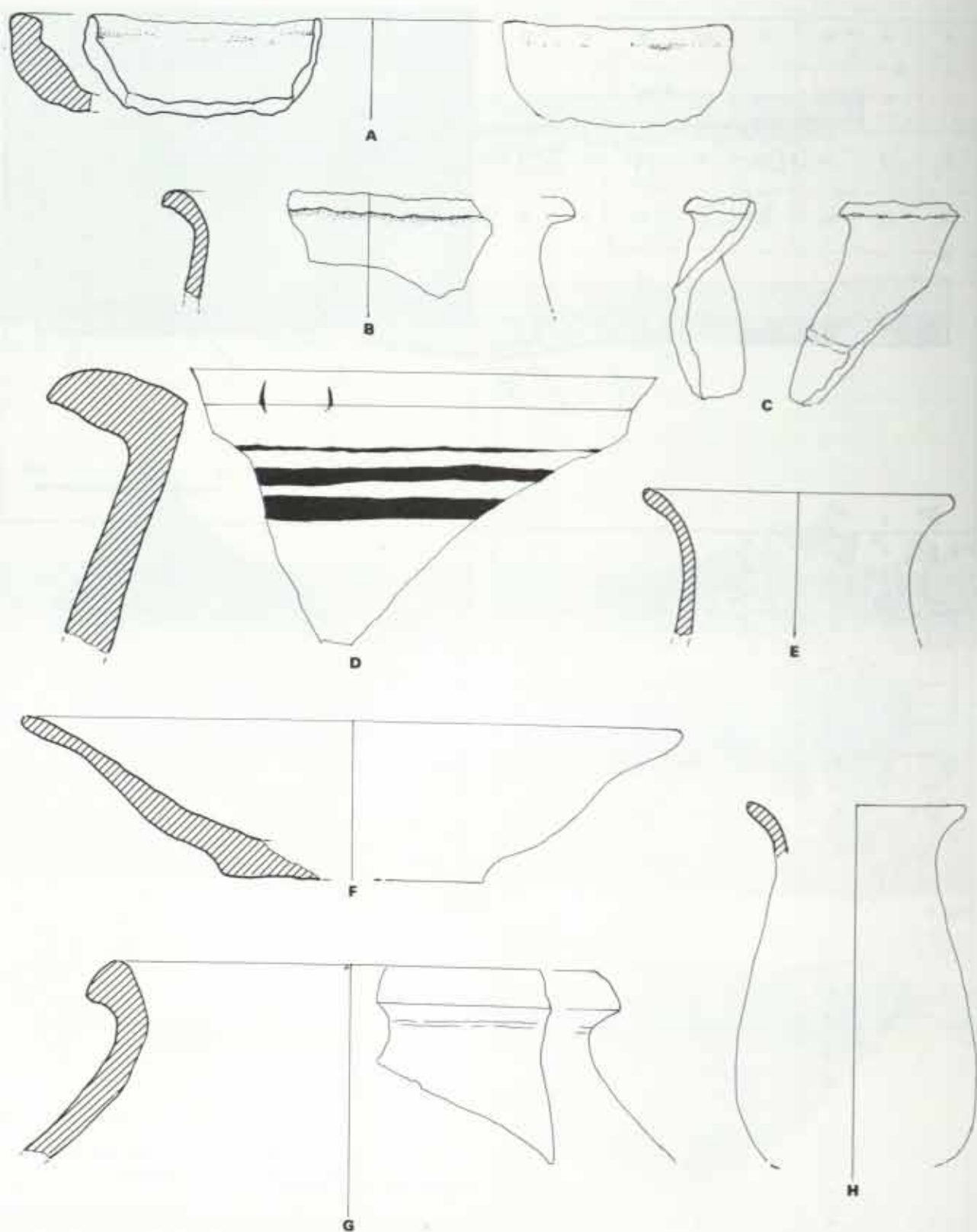


Fig. 10 Selection of fragmentary vessels forming layer (3) from tested area south of DK-B-C.



Fig. 11

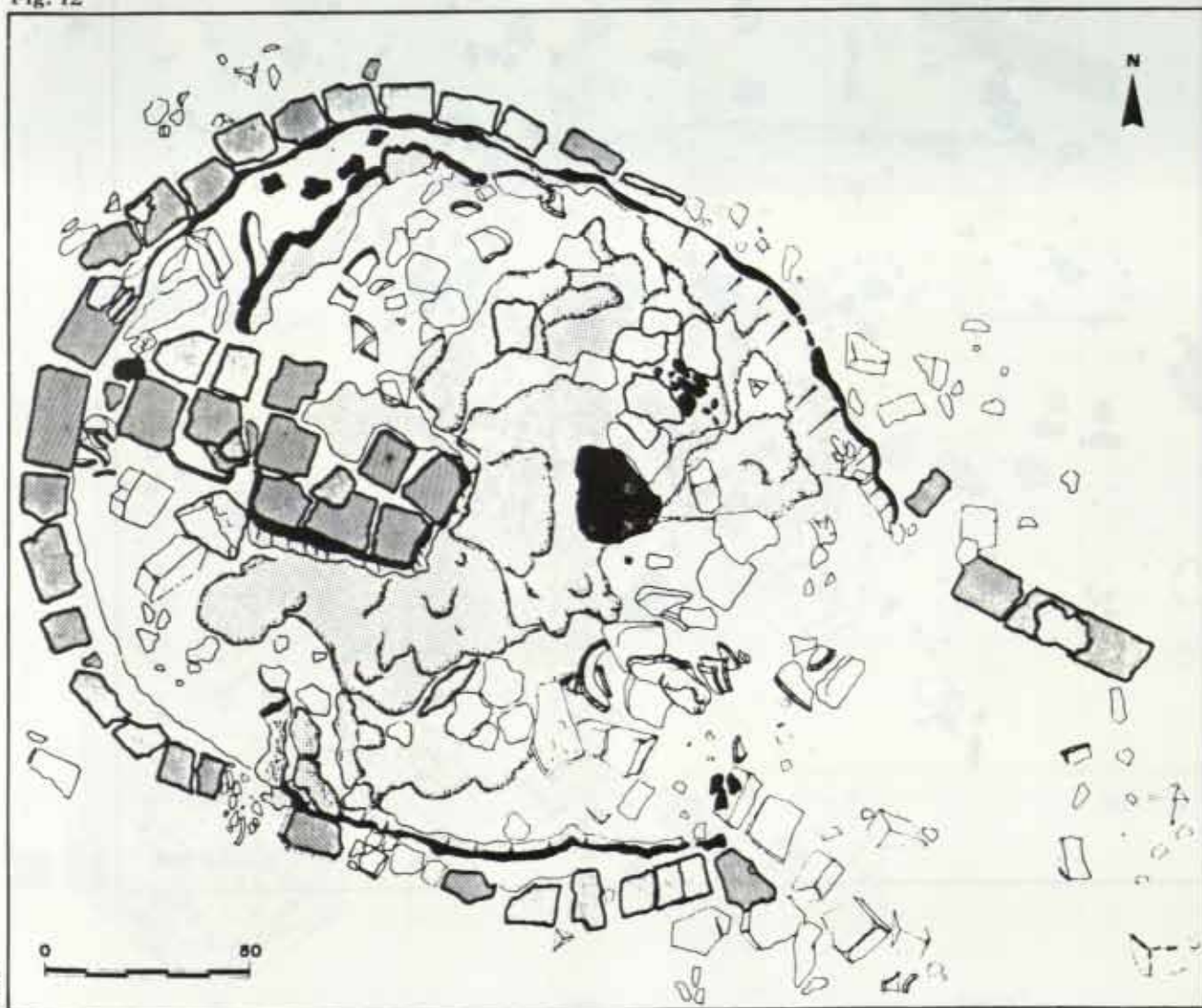


Fig. 13

Fig. 11 Clay slag concentration south-east of A.A. 27 before cleaning.

Figs. 12-13 Kiln south-east of A.A. 27.

Fig. 12



12/04/02

11/29/02

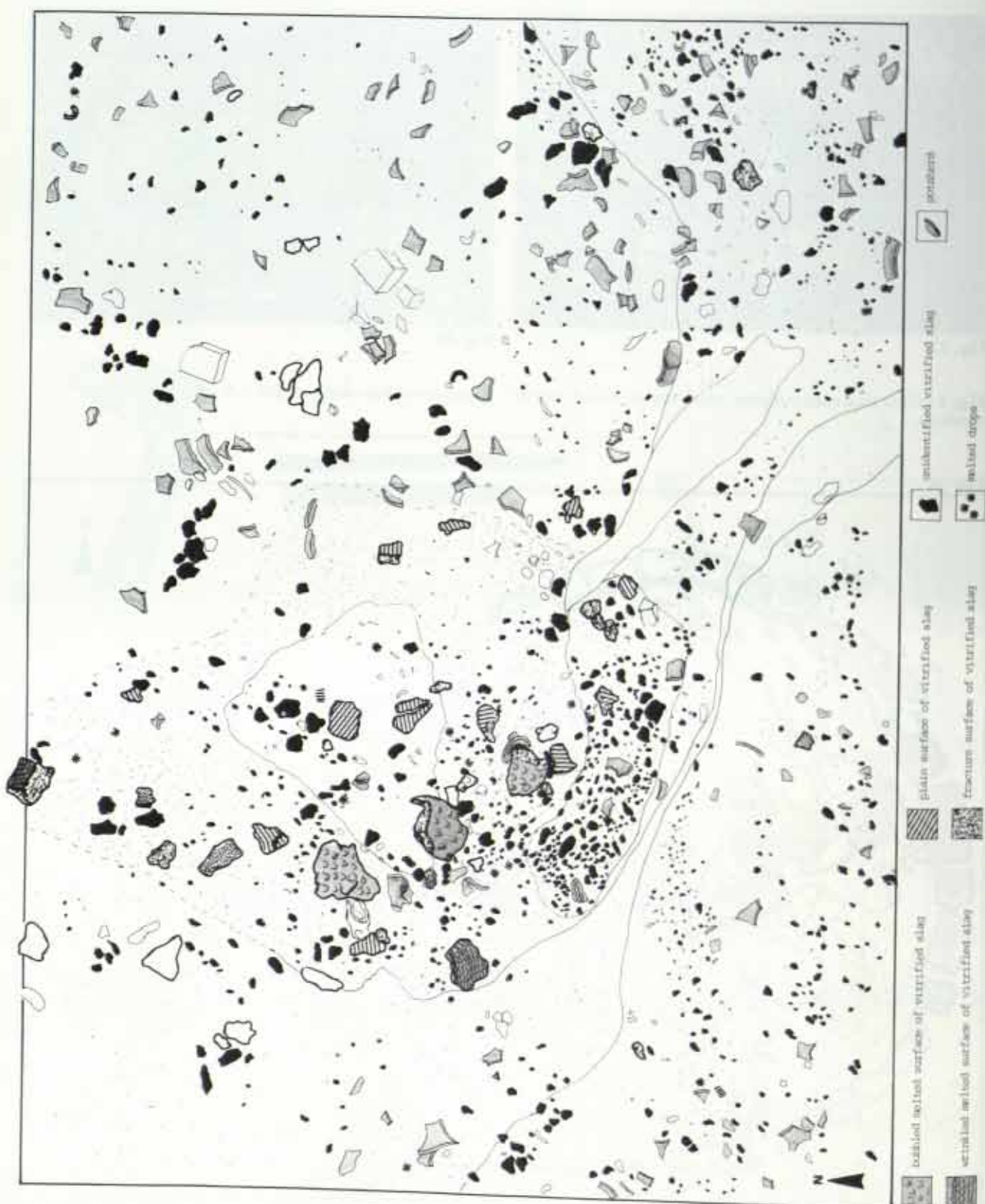


Fig. 14 Cluster of vitrified clay specimens within A.A. 32.



Fig. 15

Fig. 15 Strip trench north of DK-G showing layer (11).

Fig. 16 Cross sections of tested area within A.A. 32.

Fig. 17 Formation of overfired clay concentration as a result of the lowering of the deposit containing it due to the action of water and gravitational agents.

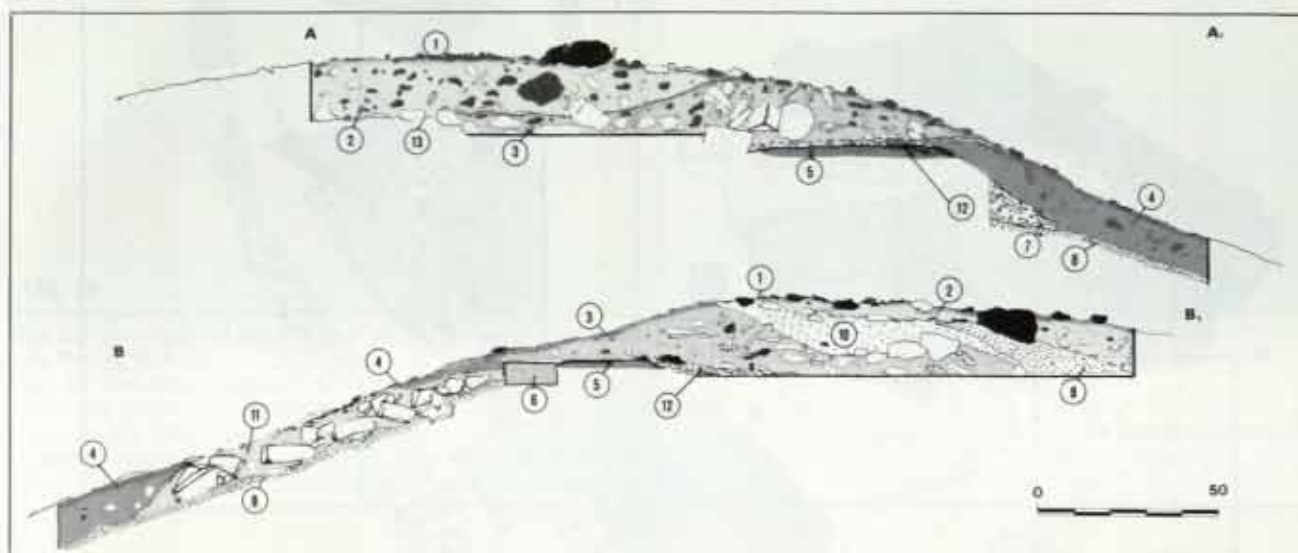


Fig. 16

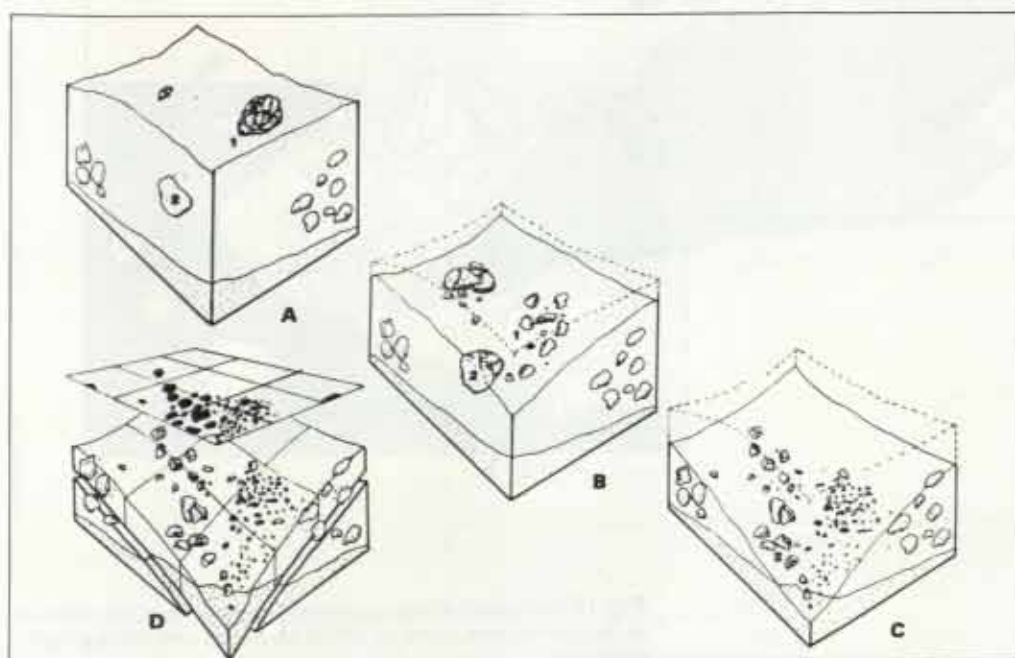


Fig. 17

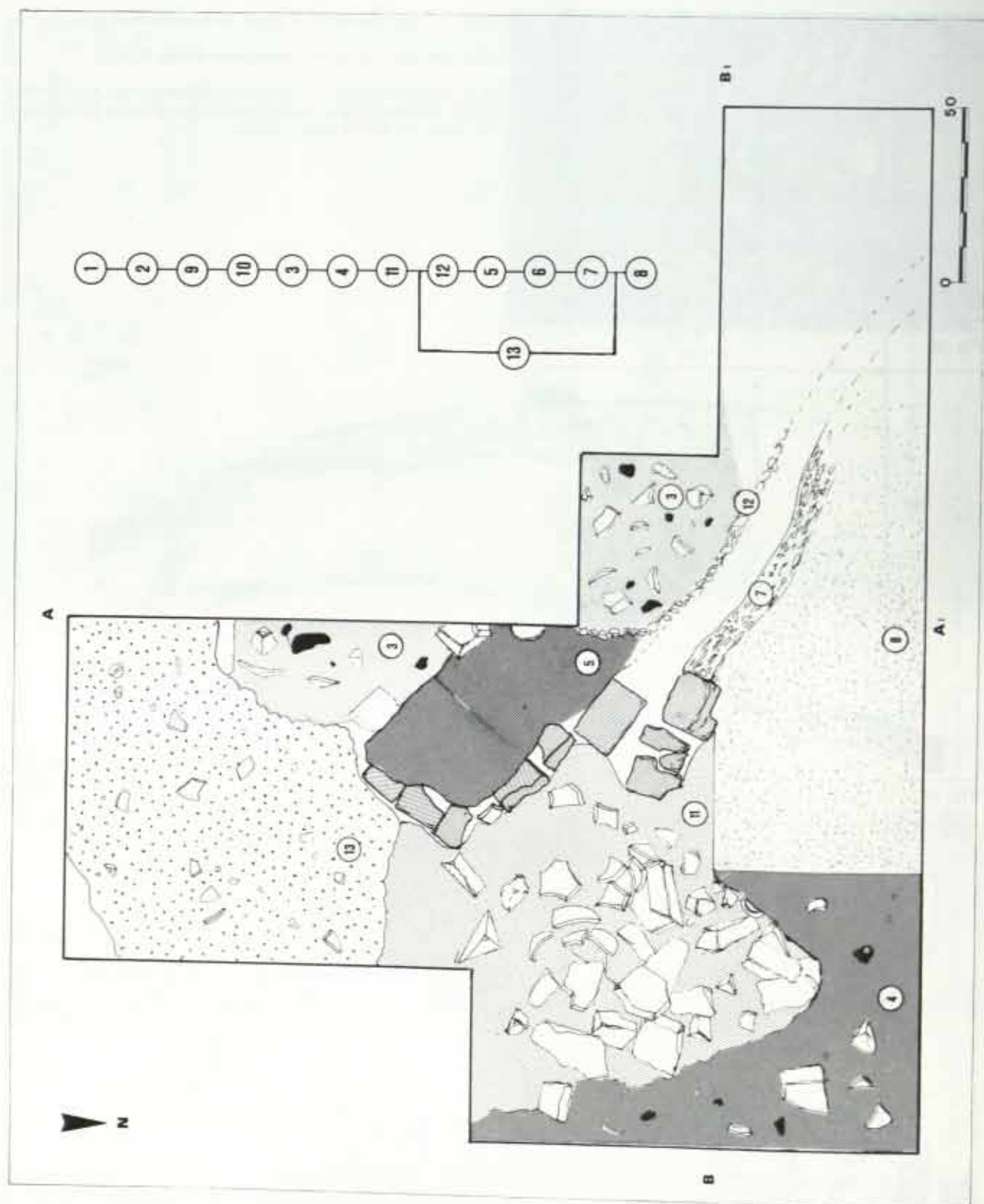


Fig. 18 Horizontal stratigraphy evidenced by surface cleaning in the tested area north of DK-G (A.A. 32) and stratigraphic sequence.

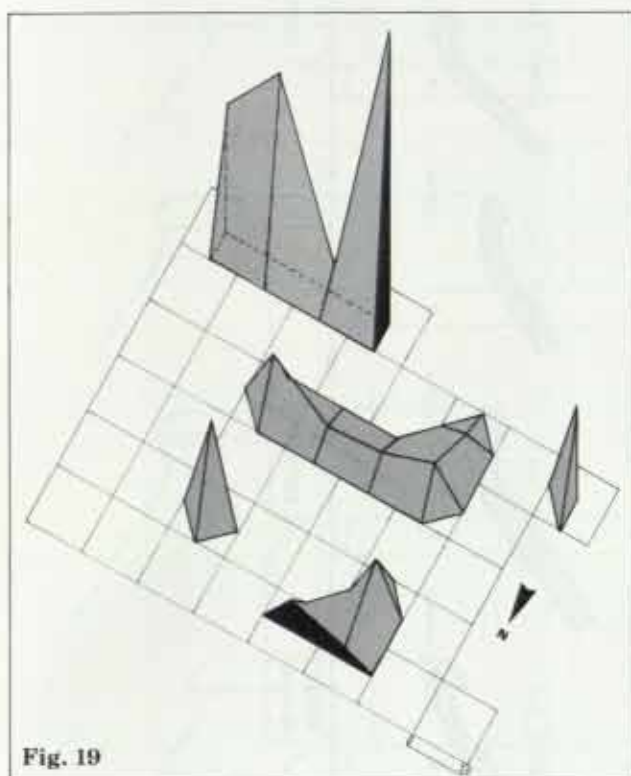


Fig. 19

Fig. 19 Quantitative behaviour of melted drops in the tested area within A.A. 32.

Fig. 20 Ponderal value of all the types of overfired clay specimens present in the tested area within A.A. 32.

Figs. 21-22 Clay slag from area north of DK-G (A.A. 32) showing vessels melted on the grate of an up-draught kiln. 1-melted beakers. 2-chaff-tempered clay lining. 3-small bricks.



Fig. 21

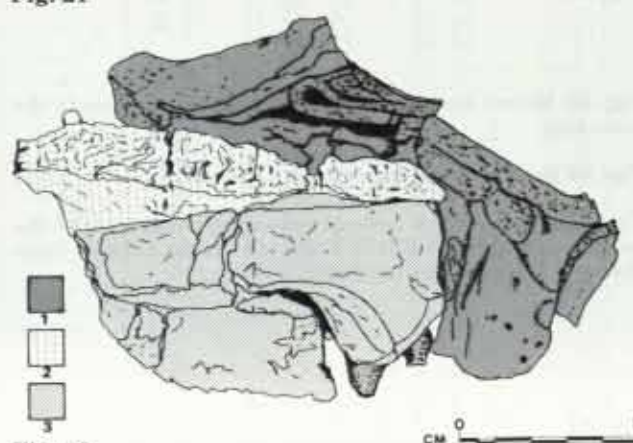


Fig. 22

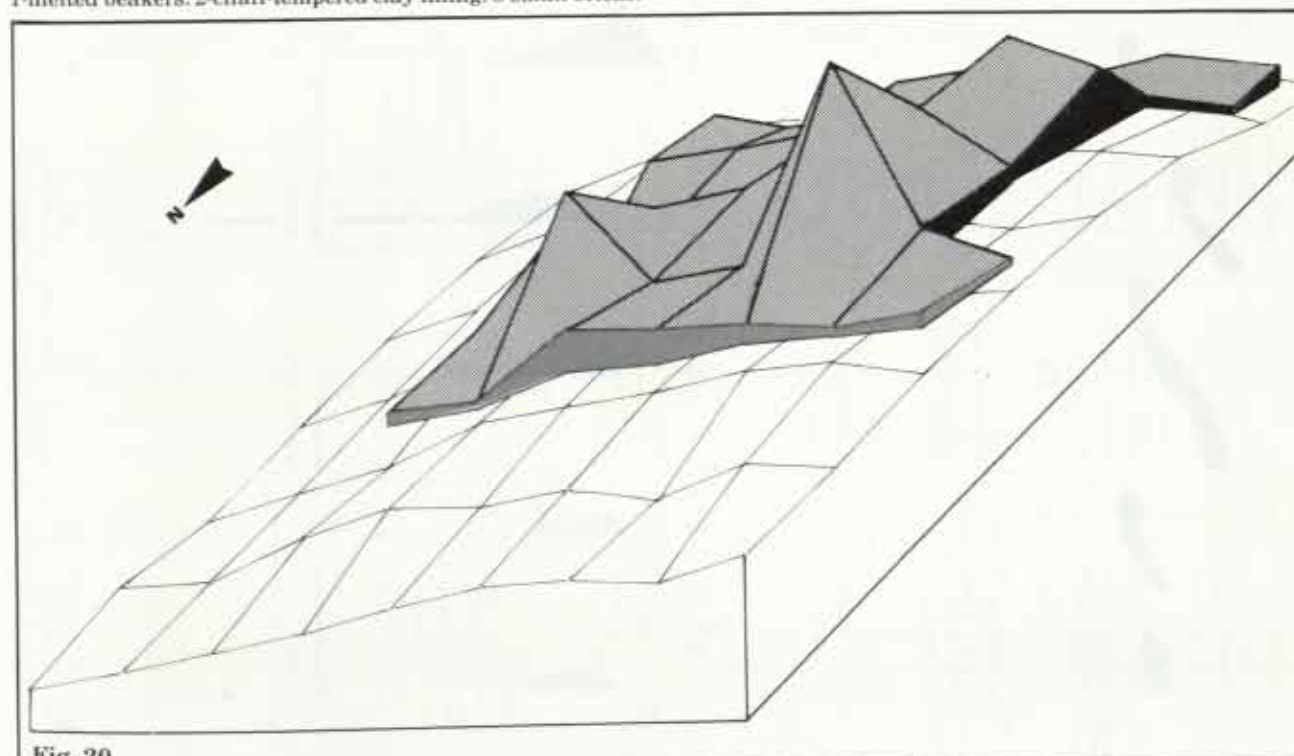


Fig. 20



Fig. 23

Fig. 23 Melted beakers and nodules melted together in the same slag.

Fig. 24 Beakers from refuse dump north of DK-G.

Fig. 25 Fragmentary beakers belonging to layer (5) of the tested area south of DK-B-C. The types are the same as those observed in refuse area north of DK-G.

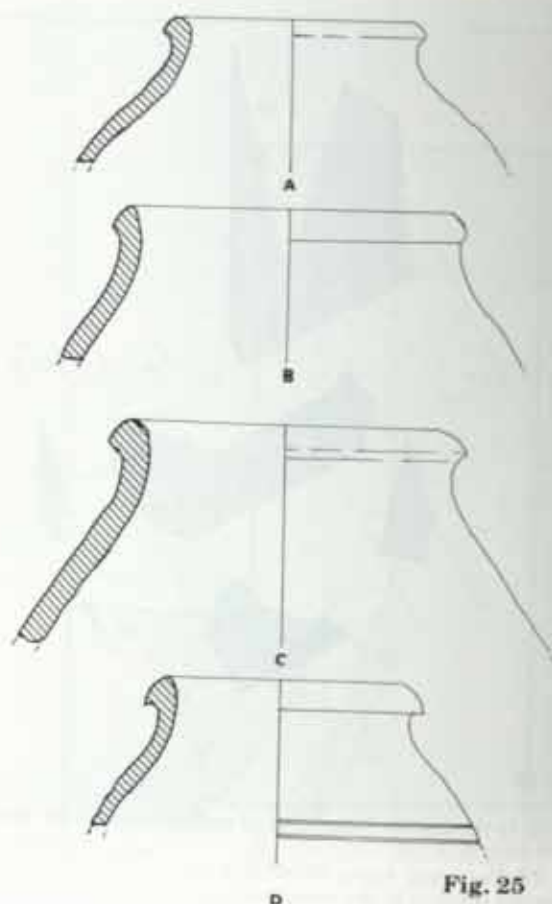
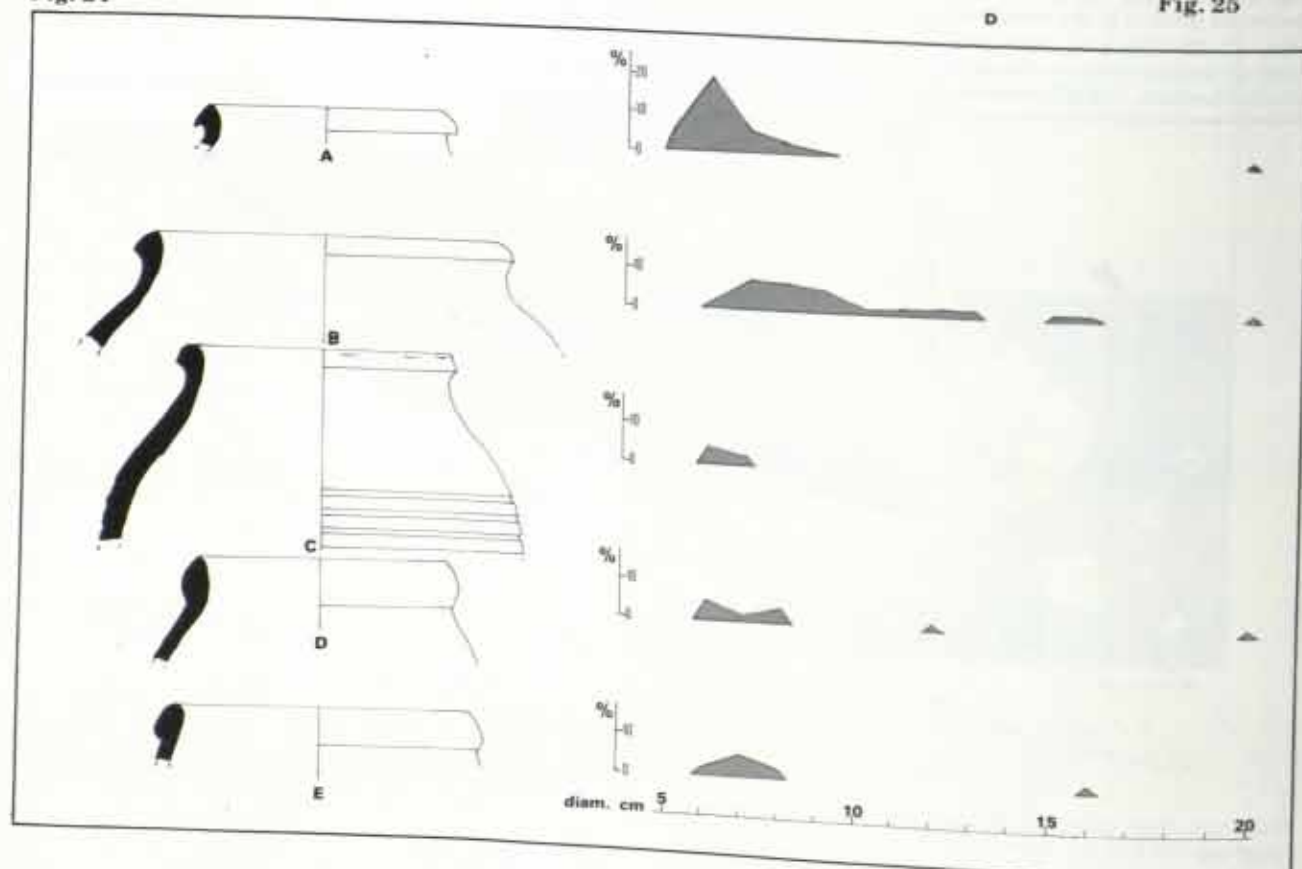
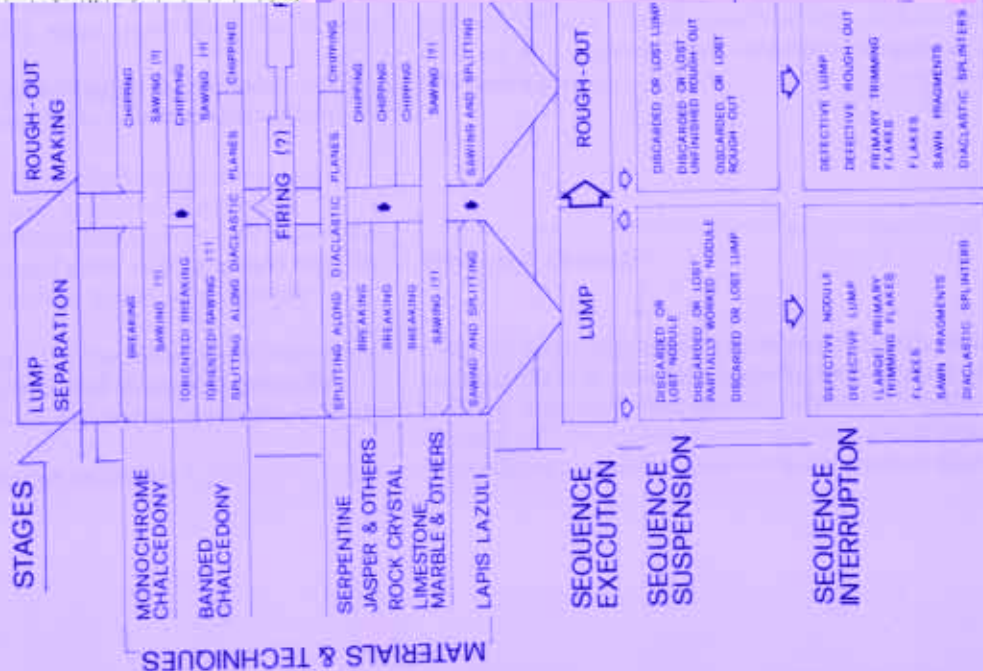


Fig. 25

Fig. 24



transformational  
and the relative



# The Mohanna — An Unknown Life on the Indus River

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Since 1979 the German Research Project Mohenjo-Daro has been carrying out a survey of this ancient town, and since 1980 I have been a member of this team. On weekend evenings we made many trips to nearby areas, and on one evening during the 1980 season some members of the team proposed a visit to the "*Sindho Daryah*" — the Indus River. We passed along dusty paths and by dense tamarisk bushes to reach the Indus. When we reached its banks we were surrounded by green fields of wheat, peas and mustard, with its thick tufts of yellow flowers swaying in the breeze. Honey bees were murmuring around the Yaktar. It was astonishing, the beauty of the Indus itself and the perfumed smell in the air of the various flowering crops spread over its banks. About 5-10 metres from the left bank we saw about 15-20 boats anchored in a straight line.

We saw some Mohanna families casting their fishing nets, and children playing close to the house boats of the village.

I asked a young peasant boy who was scaring birds from the crops of wheat with a sling the name the Mohannas gave to a boat.

I saw them making use of old technology, rowing the 6 m long house boats, or "Doondees", which provide them not only with cooking and sleeping facilities, but are also used for sailing and fishing.

Since time immemorial the Mohannas as a caste have been named after their profession. They are fishermen, "Mirbahar", and sailors, "Mallah".

The Mohanna are a shy people, unwilling to show their villages to strangers, but after several trips they became more open and I was allowed to look around the settlement. I went there from time to time to collect data and to take some measurements of a boat which was being constructed at that time by Mohanna carpenters. They told me that because of the ever-worsening economic conditions they are considering giving up their hereditary occupation. Embroidery and the art of Sindhi blanket making have already disappeared. Because of this I have made a study of the origins as well as the cultural and economic situation of the Mohanna people.

## Introduction

Standing on the Stupa mound in Mohan-jo-Daro and surveying the surrounding countryside the visitor to this ancient ruin is met with an awe-inspiring sight. About 1500 m to the east of the city lies the Indus river, and his curiosity to experience this wonder of nature at closer hand is immediately aroused. Rigveda Sindhukshit, a Sindhi sage, described the Sindhu (Indus) thus:

"Flashing, whitely gleaming in mightiness,  
She moves along her ample volumes through the realms,  
Most active of the active, Sindhu unrestrained,  
Like to a dappled mare, beautiful, fair to see.  
Rich in good steeds is Sindhu, rich in cars and robes.  
Rich in nobly fashioned gold, rich in ample wealth,  
Rich in lush grass, rich in lovely wool, rich in sweet syrup.  
The Sindhu shining with the reflection of sun rays  
It seems like a wide sheet of silver and beautiful  
With forests on both its sides, and green crops watered  
With the inundations of its banks."

## Myths and Legends

Two old men from this same Mohanna village told me some of their myths and legends. Concerning Mohan-jo-Daro they said that nobody wished to settle on the Mohan-jo-Daro ruins because they had heard from their forefathers and had experienced themselves that when

people crossed the ruins their faces and hands turned blue. This is because an evil spirit is in possession of the ruins. Bricks and other things are not taken from the ruins for the same reason.

When asked about the custom of money which is given by people to the owner of a boat or at a marriage ceremony, called "*Ghoor*" in Sindhi, they replied that this custom is very old. Take for example the houses in Mohan-jo-Daro. The costs were not borne solely by the owner; rather each inhabitant was bound to donate one brick per head when someone wished to build a new house. (The origin of this Sindhi word "*Ghoor*" is an offering given to a poor person in the name of a deity.) It is an old custom that one man's burdens be shared by many.

It operates along the same lines as a bank deposit, which is then paid out on such occasions.

The Indus River is given the title "*Khuwaja Khezer*" or "*Daryah Badshah*", the "*King River*", because of the sacred power they believe is contained in its water. It is sacred not only because it is their source of survival and provides them with shelter, but also because it is endowed with spiritual power. If anyone drinks the water as a child, then he will be protected from evil spirits. That is why the children of the village are given the water to drink, it is a sort of good-luck charm. The Indus is so generous that all who come here will have all their wishes fulfilled.

Another myth is built around the ferries. In the Muslim belief the ferry is considered as the "*Pul Sarat*", a bridge over which they could pass into paradise. Therefore nobody avoids paying the toll.

They also believe that the "*Sarenh*" or Albizzia lebbec tree is sacred because when its leaves wither, or more accurately close, in the afternoon, this is a sign that it has caught the fever of the prophet. When they themselves catch fever then they wear the bark of this tree as a good-luck charm around their necks.

Another genus of tree, the pipal tree ("*Peperu*") is said to be a genie's tree, i. e. a place where a genie lives. They avoid going anywhere near this sort of tree.

## Geographical Context

The Mohannas are a caste named after their occupations of fishing and sailing. They can actually be subdivided into two castes:

- 1) "*Mir Bahar*" — fishermen, only concerned with fishing
- 2) "*Mallah*" — boatmen, only concerned with navigation.

The Mohanna fishermen and sailors also spend a certain amount of time bird-hunting.

The women of the village can usually be found making straw mats, baskets or engaged in other minor handicrafts.

In the Sind area, Mohannas can be found the whole length of the Indus River as well as some eastern parts of the Nara, on the Manchar lake, Keenjhar lake and many other small lakes in this area. According to a report in the Sindhi daily newspaper "*Hillal-e-Pakistan*" in February 1984, they number about 117 000. Before the arrival of the British in 1843, the whole of Sind commerce depended on their "*Doondees*" and other ships.

The Indus is fed by the melting snow of the Himalayas, and then passes through Kashmir, N.W.F. Province and the Punjab before entering Sind. It flows from North/North-East, meandering through its alluvial plain in a South/South-West direction and finally enters the Arabian Sea. Sail-boats are benefited by northerly monsoon winds in the winter, and southerly ones in the summer, thus allowing them to pendulate back and forth with relative ease. It is said that Sind merchants used to travel South in the winter, selling their goods along the way, and that they returned in the summer with the winds from the South. In this way they used the natural force of wind on both legs of their journey, which turned out to be a very economical way to travel.

"The commercial magnates of Sind were very well conversant with the varied aspects of their enterprise. In the time of Shah Abdul Latif of Bhit (1689-1752), the steamboat had not yet been introduced as a carrier of Commerce. The merchants had to resort to what is commonly denominated "Native Craft", which boasted a great variety of boats of varying sizes and shapes, big and small, coasting and oceanic, "*Doondees*", "*Kotias*", Ships etc. were all found handy for commercial purposes. But all of them depended for their movements on the prevalent winds. ... in his Surs Samoondi and Sri Rag, and his poetry therefore affords an excellent picture of the Commerce of Sind during his time."

"With blowing of north-wind, a sadness burdens my heart,

For my merchant-prince is re-oiling his boat, and preparing for a voyage." (ibid.: 68)

"When the merchantmen picked up their anchor and ropes,

And spread their sails,  
The port and bazar seemed evacuated of all life and activity." (ibid.: 69)

## The Decline of the Mohannas' Economic Resources

Sailing and fishing used to form the major part of their livelihood, but both these sources have declined over the past years. There are a number of reasons for this, some of the main ones being listed below.

- i) The destruction of major commercial towns near the Indus by foreign invaders.
- ii) The use of steamboats on the Indus in the British Period (1843-1947).
- iii) The construction of railways and metalled roads. This shifted commerce away from towns lying on or near the Indus to other towns further away, situated near modern railways and roads. Because of these modern facilities, the transportation of goods became quicker and cheaper.
- iv) Modern industrialization reduced the demand for handicrafts in the towns and villages near the Indus.
- v) The construction of new dams on the Indus. The dams at Sukkur and Kotri isolated the Mohannas on the eastern Nara and lake Manchar from those living on the Indus.
- vi) The migration of local Sindhi Hindu merchants to India in 1947.
- vii) The closing of the rivers Sutley and Bias in the Punjab by India in 1970. The area surrounding these two rivers is irrigated by canals running from the Indus.
- viii) The construction of the large dams at Turbella and Mangla on the Indus.
- ix) Open auction of fishing leases. Rich landlords control the bidding at auctions and thus gain a monopoly. They then re-sell the leases to the highest bidder from the Mohannas.

For these reasons, many Mohannas can no longer exist from their traditional occupations of fishing and sailing, and are forced to migrate to land work and to join the peasant classes.

### The Mohanna Village

A Mohanna village consists of 15-20 highly decorated houseboats and a number of smaller ones used for fishing and as ferries by individual families. All these boats lie in a straight line north-south near the river bank, and form one village. The boats are secured by ropes tied to wooden stakes driven into the ground, and some boats also make use of heavy stones for anchors. There are two good reasons why the boats are aligned along this north-south axis; first, this is the direction in which the river flows, and secondly, the prevailing winds, in summer from the south and in winter from the north, cannot move their boats from their moorings. The open ground near the boats is used equally by each family for the construction of temporary huts in which they live while repairing and re-oiling their boats. These huts are built from wooden poles and beams, and are covered with rice straw or reeds.

Another small hut is built near to this which is used as a workshop for net making, straw mat weaving and basket making. This second hut is constructed in the same way as the main hut. It is also used as a storeroom for completed handicrafts, firewood and other raw materials, which are kept on the roof, leaving the shady interior free as a workshop.

Washing places are also to be found near to the boats. One narrow-mouthed straw basket full of fish is kept in the water near their boats. This supply of fresh fish is then either sold, or used by the families themselves.

The Mohanna house boat provides all the facilities needed by the family, there is space for working, sleeping, cooking, storage and even a toilet in one corner, with its outlet in the river. Drinking water is provided by the Indus, admittedly a few metres away from the boats. Birds and chickens are also bred on their boats, and when they are anchored near to the banks these fowl are allowed to run free on the open ground near the village.

The Mohannas also keep dogs, mainly to guard their villages. The ferry is situated approx. 500 m away from their village, and 500 further north they set out decoy birds as a trap to catch others.

Migrating Mohannas from another state are not allowed to anchor their boats near another village. Either they look for a spot far away from another village, or they will anchor on the other side of the river.

Villages are not permanent, but move according to the rise and fall of the level of the Indus and the ground conditions near the banks. When the water level starts to sink in September, the land left dry is usually rather different to the previous bank. Thus they migrate up or down the river, looking for flat ground, but never more than one kilometer away from their original position. This is because routes from surrounding villages lead to their ferries, and this being a large part of their income, they cannot afford to lose custom by moving too far away. During extreme floods on the Indus River, they build temporary reed huts on safe ground to stay out of danger.

### Inter-Village Relationships

The Mohanna maintain socio-economic relations with nearby villages. In the social context they are invited by the village peasantry to their marriage ceremonies and other festivals, whereby they pay an offering to the host, and bear the expenses of any rite such as circumcision as well as the wedding ceremony. They also celebrate the festivals of "Mailla" together with the

local peasantry. These "*Mailla*" are religious festivals to celebrate the anniversary of someone's death.

On an economic level the Mohanna have a clientele system with the peasants called "*Aahat*". In this system, the Mohanna provide a ferry service, in lieu of which the peasants give a fixed amount of grain at harvest time. Contracts are made between single families on both sides. Thus if one of the peasant families separates into two independent units, the new family will have to go to the Mohannas for a new contract as a separate family. Likewise when a Mohanna separates, the new family has to arrange new customers.

Most of the grain the Mohannas receive for their ferry services is kept for their own consumption. If, however, there is a surplus, the grain is sold in the nearest town or village for cash. Any extra fish is also sold in the larger towns. Any people without a fixed contract pay normally for the ferry services, and a small income is made through the sale of straw mats etc.. This money is then used to buy vegetables, butter, oil, meat from the nearby villages, and other necessities such as clothes, jewellery, medicine and material for repairing their boats, e. g. wood, iron etc. are bought in the larger towns.

### Social Organization

As has already been mentioned, the Mohanna caste can be divided into the "*Mirbahar*" and the "*Mallah*". People who leave their profession change their caste at the same time, e. g. "*Mirani*", "*Bahleem*", "*Jhaber*" etc.. In the caste are found "*para*" — which are named after their forefathers from between 12 and 20 generations ago. In one caste 3-4 "*para*" live together and form one village. 3-4 villages together form a sort of cluster organization.

Without this system social relations would break down and disputes could not be settled; the caste members would feel insecure.

Each village has its own social rules, based on the area where it is found and on the other hierarchic systems found in the surrounding villages. Minor differences also arise in rites and customs through differing religious beliefs, for example between the Shia Mohanna and the Suni Mohanna, which then appear as differences in the social organization. Through this social structure equal fishing rights are maintained, help is given at ceremonies, and disputes settled fairly.

The father is the head of the family, and one "*para*", or group of families, jointly elect one spokesman, usually an older man who has a better social status and more experience than others.

The heads of all the "*paras*" form one group in the village hierarchy. These then elect one delegate for the whole village, who is in a socially higher position than anyone else.

The chiefs of the villages elect one member as the chief of the whole caste of the boatmen — fishermen and sailors.

There are two ways of settling a dispute in a Mohanna village. In the first method, both parties involved select an equal number of arbitrators and one head as a judge. The affair is discussed before the whole village, with each member giving his opinion in support of or against one party or the other. After this open discussion, the arbitrators and the judge confer together to decide on the outcome. A majority decision must be reached, if the arbitrators are split equally then the judge has the deciding vote. This solution is called "*Aminanjo Faislo*".

The second system of settling disputes operates along the same lines as the first. It is usually used in disputes with other local castes, and in this system the leader of the caste has the superior position, the heads of the villages have a secondary one and the villagers themselves the lowest position in decision making.

In the Mohanna social structure the men have a dominant position over the woman. According to their marriage system, there can be no marriage with people from different religious groups or castes nor with Mohannas from other states e. g. the Punjab ("*Pardaisi*"). Although they could be neighbours, performing their own customs and with their own traditions, no relationship is formed between the two communities.

### Subsistence

The staple diet of the Mohannas is fish, rice or rice bread. The fish are caught in the Indus, and rice is given by clients as a form of toll for the ferry services. Although rice is the major grain crop in this area, some peasants also cultivate wheat, thus wheat bread can sometimes be found in the Mohanna's diet. Meat, vegetables, ghee, tea and sugar are bought from the markets in the nearby villages, although most of the Mohanna are so poor that such goods are almost a luxury. Fresh fruit and milk are not included in their diet.

As has been mentioned, drinking water is taken directly from the Indus. Because of this impure water and the poor nutritional conditions, the majority of adults and children are plagued by infectious diseases in the winter; colds and coughs spread rapidly throughout the whole community. In the summer, mosquitos are abundant, breeding readily in the mud and stagnant

waters, and because of this malaria and fever are frequent hazards for the Mohannas.

## Shelter

The house boats of the Mohannas are called "*Doondees*". One family may live in the same small boat for as long as half a century. These "*Doondees*" range in size between 6 m long and 2 m wide up to a length of 14 m and a width of 4 m in the middle of the boat. The boat is basically steered by a gibstaff. In deeper waters, the Mohannas employ a very simple steering oar made from a wooden pole supporting a small wooden plank. The two elements are connected together by a leather rope. The steering oar is operated in the stern section. The boats are fitted with a mast erected in the prow section. Finally, the boat is controlled by a wooden rudder.

The boat can be subdivided into three parts: prow, cabin and stern. Traditionally the prow provides the cooking area on the house boat. In this part of the boat are kept the grinding mill stone and the unbaked clay ovens. The cabin, covered with straw mats, is used as a living and sleeping area. The stern, where the rudder and steering oar are fixed, seems to be left for controlling the boat. Under both prow and stern are two large cavities utilized as storage space. In the stern are also fixed the pennon-like strips. The Mohannas could not explain their function, but simply said they served as decoration. In the stern section can also be found the ensign poles. These ensigns, besides being used as decoration, also seem to indicate wind direction.

A small house boat can accommodate a maximum of 6 family members, whereas one of the larger boats has room for up to 15 people.

## Different Types of Boat

The Mohanna have several types of boat. The "*Doondee*", as well as being a house boat, is also used for fishing. The "*Nau*", with the cabin in the stern, is used as a ferry; the central open space being left for loading and unloading goods and people.

The person sailing this type of boat is called "*Naukho*". "*Patelo*" or "*Batelo*" is a small boat without rudder or cabin. Easy to row, it is used for fishing and transport. A total of more than 12 types of boat are used by the

Mohannas of Sind. The Mohannas in the village in question made use of only the three types described above. Other forms are used on the lakes and open sea. The price of a small boat is about 4 000 rs., while the larger ones may cost anything up to 36 000 rs.. Usually the families living in the smaller boats cannot afford such sums of money. The Mohannas living in the larger boats mostly have contract for the ferry, and earn more than the simple fishermen.

## Construction of a Mohanna Boat

The boats used by the Mohanna throughout the centuries are a central element in their daily life; they represent at the same time a house and the basic unit of production. The boats are constructed by Mohanna carpenters from mast tree wood, which is both light and strong. The trees are felled in the forests to the north, and transported downstream from the Sukkur dam.

The first stage in the construction of a boat is the formation of the sides, strengthened by rib-like pegs. In the second stage, the bottom of the boat is formed, broad in the middle section and narrowing symmetrically at both ends. The ends are also bent upwards, this being achieved by moistening the wood beforehand. Similarly to the side pieces, the bottom of the boat is strengthened by nailing a series of lateral ribs to the floor. The sides are then fixed onto the base. The prow and stern are then covered with planks, supported by further wooden ribs. Except for the use of a few large nails, the whole construction is held together by bamboo dowels. These expand in water and give an overall stability to the construction. Metal nails are rather impractical because of the problem of rusting. The next step is the construction of the central cabin. This is formed by a rectangular frame covered by planks, or sometimes simply wooden sticks, and supported by 4 poles. Poles and ceiling are joined by a simple dowel and socket system. Finally the carpenters add the rudder, the pennon-like strips for ensigns and the steering oar. On the larger ferries and house boats an additional cabin is sometimes constructed.

The Mohanna carpenters are skilful woodcarvers. Every part of the boat is carved by hammer and chisel with elegant motifs in the form of floral designs, or sketches of birds or fish. Each artisan has his own repertory of motifs; unfortunately no copies could be reproduced for publication. Pre designs of pre models are not prepared by Mohannas.

The same amount of skill is clearly shown by the system of measurement and boat planning they use. As a unit of measurement they use the width of one

finger; 12 fingers form one hand (the width of the hand is calculated from the tip of the thumb to the tip of the little finger); 2 hands are equivalent to one arm unit, and 2 arms are equal to one yard. Similarly, the planks are cut with angles which are simply memorized. Straight lines are drawn with a thread dipped in charcoal water colour. This technological simplicity is reflected also in the very restricted inventory of tools needed for boat construction: the saw, the adze, the chisel, the hammer, the drill and the carpenter's plane, plus the above-mentioned thread for the straight lines.

### The Boat Inauguration Ceremony

The Mohanna fishermen and sailors living on their house boats have one tradition that has been handed down from their forefathers. It seems they believe in omens, a remnant of Brahmani bibliomancy. They are muslim, and mix this belief with old traditions and customs in their everyday life.

The carpenter has to inform the owner one week before the completion of the boat. This gives him time to invite all the relatives, neighbouring Mohannas and the local people living near to the village who are allowed to participate in their celebrations.

The owner also invites musicians and a "*Mullan*" to pray on the day inauguration. He then has to buy rice and other food and very likely borrow cooking pots. The owner's family then meets together to decide upon a good day and date for the inauguration. They prefer even numbers ("*Bhadi*") to odd ones ("*Eki*") because even numbers are thought of as numbers of unity, and odd ones of disunity. Also Saturday ("*Chhanchhar*") and Tuesday ("*Aangaro*") are considered to be bad luck days. This is because "*Chhanchhari*", which means a Brahman who averts the influence of the planet Saturn, belongs to Saturday, and Tuesday is said to be unlucky in bibliomancy books.

The celebrations on the day start before noon, when all the participants have finished their work. Tents and reed huts are erected for the men near to the new boat, and more tents and huts are erected about 100 m further away for the women. The musicians play romantic, traditional folksongs, but only for the men. The women sing for themselves. The food is then served. A barber can be found in the men's tents cutting hair. He is paid by all present.

In the afternoon the Mohannas start to decorate the boat. They fix ensigns made of decorated coloured cloth onto the stern of the boat. The carpenter then makes a last check, and when he is satisfied he fixes the "anchor poles" on the prow. His work is then completed. All the participants then lay down tamarisk sticks in a line from the boat to the river. Water is

then sprinkled over these to ease the transport of the boat. Strong jute ropes are then tied to the anchor poles on the prow.

The carpenter is then called and given a new set of clothes consisting of turban, shirt and trousers. This is the traditional gift given by the owner.

Then the owner or a member of his family scatters grains of wheat and rice over the boat. This is an omen in Brahmani bibliomancy which is said to ensure a large income, abundance of grain and food and a peaceful life for the family as long as they live on the boat.

The "*Mullan*" is then called onto the boat, and all the people raise their hands in prayer. The "*Mullan*" has memorized the whole of the Koran, and he now recites some of the verses from the Koran, e. g. "God may protect them from disasters, make them rich . . .".

After the prayers everyone has to pay between 5 and 50 rupees to the owner of the boat. This is the same at each ceremony. Then the participants divide into two groups and begin to pull the boat from both sides into the water, with much singing and chanting to keep time. At first the boat is pulled in a zig-zag to get it moving, and once in motion on the tamarisk sticks it is pulled directly into the water. When the boat is finally in the water, everybody crowds on board and they all receive a small bag of sweets which have been kept especially for this occasion. The inauguration ceremony inevitably ends with happy scenes.

### Family System

Each Mohanna family consists of between 7 and 11 members. The birth of a son is thought of as a guarantee of help and support for the parents in old age. With a daughter it is said that she will go to serve another's house — "A daughter is like a transplant; where she is transplanted, then she will grow there for ever". The son, however, will stay together with the parents until he is married. In some families one son is duty bound to stay with his parents until another brother marries and his wife can serve the parents. After the death of the father, the sons receive equal portions of his property, and the daughters only receive the half of their brothers' share.

### Marriage Systems

The parents of the girl and boy arrange the engagement. In some cases the boy may be allowed to choose

himself, but a girl never has a choice. When a girl is 14 years old she is thought of as adult, and her parents look around for a partner. The Mohanna have the same marriage system as that of some tribes living in upper Sind. There are two systems to arrange a wife.

One way is the exchange of girls; one adult girl for another, or two younger ones for an adult, or a younger girl and a sum of money ("*Gurth*"). In some cases it is even arranged for one young girl and the next girl to be born either in the man's family or the adult girl's first baby daughter ("*Paitu*").

The second system is to sell the girl for money, anything between 10 000 and 25 000 rupees.

When the engagement has been settled by both families the betrothal ceremony is performed. All relatives and neighbours are invited by the boy's father to the girl's father's house. This gathering of people is called the meeting of the fraternity (Brotherhood) of "*Ghur Kheer*" (Gur and milk). The girl's father has to declare the engagement of his daughter by giving the man's name. The fraternity members (all the people living in the village) are witnesses.

If one of the parties breaks his or her promise, then they will be punished by the fraternity. After the engagement has been declared, the parents of the man distribute sweets among the guests. In a few cases the "*Mullan*" is called upon to declare the matrimony and set it down in writing ("*Nikah*"). But usually this religious rite is performed at the time of the actual wedding, in which a marriage position is settled by the husband upon the wife in cash or gold and silver jewelry. In case of divorce or death of the husband without children she can use it for expenditure which is called "*Hag Mahar*" in Sindhi.

### The Marriage Ceremony (*Shadi*)

When the girl is 14 years old the parents of the betrothed man come to the girl's parents to ask permission for a wedding date ("*Fix Teth*"). The date is then fixed, bearing in mind lucky days, months and dates (see section on inauguration ceremony).

5-7 days before the appointed date the "*Vanwah*" or "*Khumbo*" ceremony is performed. A procession of women pass from the bridegroom's house to the bride's. The parents of the bridegroom give about 4 kg of butter oil, sweets and bright red cloth, "*Khumba lata*", to the bride. During the "*Vanwah*" or "*Khumbo*" period the bride and groom are not allowed to leave their respective homes. The groom wears a red woollen string around his wrist, and one ornament of iron to ward off evil. Neither bride nor groom is allowed to eat curry because of the sour taste of chilly, nor can they eat things cooked on a fire. Fire and sour foods are not a

good omen for lifelong relations. The bride wears bright red clothes, and her mother rubs dry flour over her whole body to make it shine. This application of flour is called "*Aaton*". One day before the wedding *Lawsonialba Henna* ("*Mendee*") is applied to the hands and feet of the bride and groom in their own homes.

During "*Vanwah*" or "*Khumbo*", many rituals, mixtures of Muslim and Hindu, are performed to ensure a happy and loving life for the couple.

On the day of the wedding the groom reaches the home or village of the bride before sunrise, followed by a procession of men and woman in decorated boats. The women sing folksongs ("*Lada*" or "*Sehra*").

The groom has to take a bath there and put on new clothes and a new turban. Many rituals are performed by the bride and groom, mostly relating to the bride winning the groom. Religious perfumes are then applied to the bride and groom. After matrimony, the groom is called into the bride's boat for "*Lawan*". The sisters of the bride and groom then knock the bride's and groom's heads together seven times (Brahmanic Hindu marriage ceremony). The women then tie a band, ("*Morah*"), decorated with embroidery, mirrors and beads on the bride's forehead. They then tie the corners of their shawls together, "*Ajak*" and "*Poti*", this ritual being called "*Palva Badham*". Finally, a specially decorated boat carries the couple to the groom's house.

### Other Ceremonies

Circumcision ceremony. "*Tuhaar*".

This ceremony is variously celebrated. The poorer people only distribute sweets to their guests, while rich families arrange for food to be served and receive an offering "*Ghor*". Most children are circumcised before reaching puberty in the Mohammadan belief, and in any case before they marry.

"*Bas*"

This ceremony is celebrated near the grave of a Saint. Meat and rice are cooked as an offering when desires have been fulfilled by the saint, for example, on the occasion of a birth or marriage.

### Festivals

"*Maila*"

This festival takes place in three villages in Sind once a year. It is held on the anniversary of the death of a saint and lasts three days, usually centered around the saint's grave or tomb.

Musicians and singers come and play romantic folk-songs, travelling salesmen sell toys, sweets and handicrafts. Sindhi wrestling bouts take place alongside horse and camel races. During "Maila" the streets are decorated with coloured flowers, and all the villagers come in brightly coloured clothes to buy the cheap goods on offer.

The Mohanna go to the nearest "Maila" in either Baheriji, Mahmmud Shah or Dokri. Apart from these three "Mailas" there are three other large "Mailas" in Sind: at Shah Bittai near Hala, Lal Shabaz Qualander in Sehwan and Barea Sharif in Ranipur. Some Mohanna travel to these "Mailas" also.

Apart from the "Maila" celebrations, every village in Dokri Taluka arranges bullock cart racing. This is also a great source of entertainment for the Mohanna and the other villagers.

### Some Basic Aspects of Mohanna Economy

#### Fishing

As already stated, fishing is historically the basic activity of the Mohanna. The normal fishing season starts in February and lasts until June. In February, when the Indus becomes narrow and shallow, the Mohanna can cast their nets across the river, blocking its course completely. This extends along both sides for approx. 2 km.

The whole village gathers at this time to exploit this opportunity. Each house boat casts its nets, and the whole family helps in the work. It is very often the case that the woman row the boats while the men haul in the nets. These collective fishing activities are under the supervision of a Mohanna chief, who is there to see that each family has an equal chance. All families are bound to accept his decision. On the other hand the Mohanna collectively pay a contract fee to the Government for fishing and bird hunting. The fish are sold to fishmongers, who are also Mohannas. In turn, they sell the fish to the neighbouring towns and villages. In times of abundance, the product is distributed directly in the towns' fish markets. A certain amount of the catch is kept in narrow-mouthed baskets for their own consumption.

The fish usually bring about 10-12 rupees per kilo, and during the good season each family can count on approx. 8 kilos daily. When the collective fishing season ends, the nets are cast individually, and as a rule each family catches about 2 kilos per day, which is then used as food for themselves.

There are 7 kinds of fish caught in the Indus:

- 1) "Pallo" — the "Hilsar" of Bengal, so-called "sable-fish" (Clupeidae fam.)

- 2) "Gandan" — a knife fish (Notopteridae fam.)

- 3) "Khago" — a sheat-fish (Siluridae fam.)

- 4) "Morakhi" — a carp-fish (Cyprinidae fam.)

- 5) "Dambhro" — a carp-fish (Cyprinidae fam.)

- 6) "Singari" — a sheat-fish (Siluridae fam.)

- 7) "Poiki" — a sheat-fish (Siluridae fam.)

#### Bird hunting

Bird hunting is another important Mohanna activity. Migrant birds reach Sind in the winter season. The Mohanna employ for hunting at least a couple of decoy birds, which are tied to a stick in the water. The only device used by the Mohanna for catching the birds is a bird mask, which floats on the surface of the water as the swimming hunters approach.

The birds are then simply caught by hand from underwater. Unlike fishing, bird hunting appears to be forbidden for women. The captured animals are either sold inland or eaten directly by the hunter's family. The birds caught are migratory birds which come from the north in the winter season. Each bird is sold for approx. 15 rupees.

#### Craft activities

The technology used in producing the small handicraft items is very old and simple. The products are either used by the producers themselves or sold to the nearby villagers and contractors.

The raw materials for the straw mats and baskets are collected from the Indus. The men cut the tamarisk sticks and reeds from the river bank, and the elephant grass from small ponds near the river.

The tamarisk sticks are left out in the sun to dry for two days. Then are they kept for one day in water, and on the second day they are ready for use. The women can produce two mats in one day, which could be sold for 8 rupees each. A narrow-mouthed jar, costing 12 rupees can also be completed in one day, whereas a large straw vessel for grain costing 150 rupees takes 6 days. The mats made from elephant grass take two days and cost 25 rupees. The men occasionally make fishing nets and then sell them to other Mohannas, making a profit of around 20 rupees per day. It takes 3 days to make one small net.

#### Dress

The Mohannas wear the traditional dress of the Upper Sind region.

#### Male dress

"Pateko" — the turban

A loose thin cloth, 4-5 m long, made of cotton or silk tied around the head and worn by every adult. The

turban of honour or chief's turban is tied in a ceremony before all the members of the village on the selection of a new chief. When the father dies, the turban is passed on to the elder son, as the new head of the family, and is tied in the presence of relatives and members of the village in another ceremony. When two friends exchange their turbans it is said to be a sign of bosom friendship.

*"Kamees"* — the shirt

The old men of the Mohanna still wear the traditional *"Pahryan"*, a shirt without collar or cuffs. However, younger people wear modern shirts with collars and cuffs. These reach to the knees, and are made of various coloured cloths.

*"Shalwar"* — trousers

Wide and loose, containing 4 m of cloth, various colours.

*"Poterio"*

A loin cloth tied around the head.

*"Gode"*

The dhoti is fastened by crossing both ends at the front and tucking them in. While working in the village the men wear a *"Gode"*, but for ceremonies and for going into town the *"Shalwar"* is worn.

*"Ajrak"* — shawl

The famous traditional shawl, hand-printed with geometrie floral designs and eight cornered white stars. The designs are either dark red on a blue background, or vice versa, but the stars are always white. Sind is the only place in the world where these Ajrak are made. The theory has been put forward by several Sindhi scholars that the priest-king from Mohan-jo-Daro is wearing the same type of cloth with floral designs. Moulana G. M. Germani has written in an article: "When invaders were burning the libraries and books of Sind, Sindhi people printed this cloth with many secret hints".

Female dress

*"Poti"*

A block printed cloth of various colours, wrapped around the head and shoulders of women. It is thought to protect the woman's honour by hiding her face from strangers.

*"Burko"*

A veil covering the whole body down to the feet with eye holes. Women wear this when they leave their house boats, for example to visit parents or to go to town to buy medicine. According to Mohammadan law it is worn for privacy, i. e. so that strangers may not see any part of her body.

*"Cholo"*, or *"Kamees"*

A shirt worn by women, with block prints of a floral or geometrical design, decorated with embroidery around the neck, shoulders and arms.

*"Suthan"* — trousers

Made from the same material as the shirt. The lower edges of the trousers are decorated with embroidery.

*"Juttee"*

The leather chapal, traditionally with a woollen flower on the front.

## Language

The language spoken by the Mohanna is a dialect of the upper Sind region, actually a literary dialect of Sind. But the Mohanna have also preserved many words from the old vocabulary, present in the poetry of the classical poet of Sind, Shah Abdul Latif of Bhit (1689-1752). These old words have been forgotten by the present writers of Sind and are not spoken by people living on the land in the same area as the Mohanna, or at least not in the villages and towns where modernization has had an influence on society.

It is remarkable that the rural areas of Sind also preserve the old vocabulary. It could be because the small villages are somewhat isolated from the larger towns, have no access to modern literature and are very much self-sufficient.

## The Protohistoric Evidence

The trade relationship between the Indus Civilization, the centres of the Persian Gulf and the great towns of Mesopotamia have already been discussed and reported by several scholars, on the basis of the evidence discovered from the protohistorical sites of the above mentioned civilizations.

The most important body of data available to date is formed by the written documents unearthed in Mesopotamia, dated to the period between Sargon's conquest (2351 B. C.), and the so-called Isin-Larsa period (about 1800 B. C.). The tablets record movements of ships loaded with commodities coming from the faraway countries of Dilmun, Magan and Meluhha. It is generally assumed that this last political entity should be indentified as the complex of the Indus Civilization. The great West-East sea route was apparently open for at least 5 centuries; during this period, it complemented the inland trade routes in providing the Indus centres with all required commodities.

A centre like Mohan-jo-Daro, rising from the banks of *Sindhu Darya*, had to rely heavily on river facilities for transport services.

Notwithstanding the environmental constraints, we can imagine the Indus system as some kind of natural

highway supporting part of the enormous trading network which furnished the towns with products coming from a very wide and diversified range of countries and regions.

The representations of boats discovered at Mohan-jo-Daro could be considered, in this perspective, as a record of the "Chiefs of the Water", *Mirbahar* and *Mallah* who were known to the Harappan people. In comparing the boat represented in the seal reported by Mackay (1938: 30, Pl. LXXXIV) with the actual Mohanna boats we can observe that the protohistorical boat has a more strongly upturned prow, while they appear very similar in having a central cabin; the pennon-like strips which are represented on both sides of the cabin could be seen as analogous to the ones visible in the stern section of Mohanna boats. The steering oar on the seal boat representation would appear structurally identical to the modern specimens.

According to Mackay: "... this boat is shown as lashed together at both prow and stern indicating perhaps that it was made of reeds" (ibid.: 30). The oldest historical accounts of this topic indicate that in the 8th century B. C. Sindhi people were constructing their boats from coconut planks connected by ropes (Tareek Tamdan Sind: 193). The pottery sherd with graffiti (Mackay, 1938: Pl. LXIX, 14) represents a boat with sharply upturned prow and stern, apparently controlled by a single oar. The boat seems to be provided with a rudder, and a system of vertical and horizontal lines in the centre probably indicate a furled sail. A third boat representation from Mohan-jo-Daro provides us with further information. Stern and prow, as in the former representations, appear upturned. The central cabin is endowed with the pennon-like strips we have encountered in the first case, again placed on both sides. In correspondence with the stern, one line suggests the presence of the steering oar, while the second could represent the rudder. Two birds are arranged symmetrically on the boat, making us think of the present-day Mohanna practice of keeping at least a couple of birds on each house boat.

On the whole, the available evidence, although very scanty, would seem to indicate a series of morphological and technological convergences between the protohistorical boats and the Mohanna ones.

Given the central role of the seals and sealing devices within administration systems, we could infer that the role of the protohistorical "Chiefs of the Water" in the transport services and, more generally, in the economy of the town was a very substantial one.

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Fig. 1

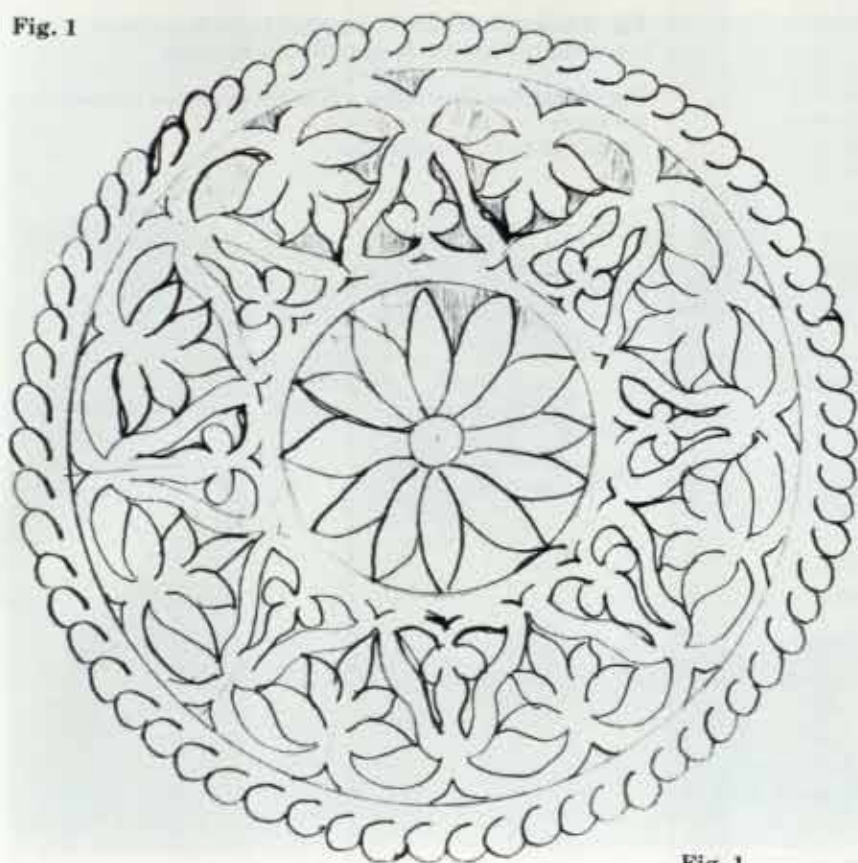


Fig. 1 Wood-carving ornaments.  
(Drawings by Ghulam Ali Mohano).

Fig. 1

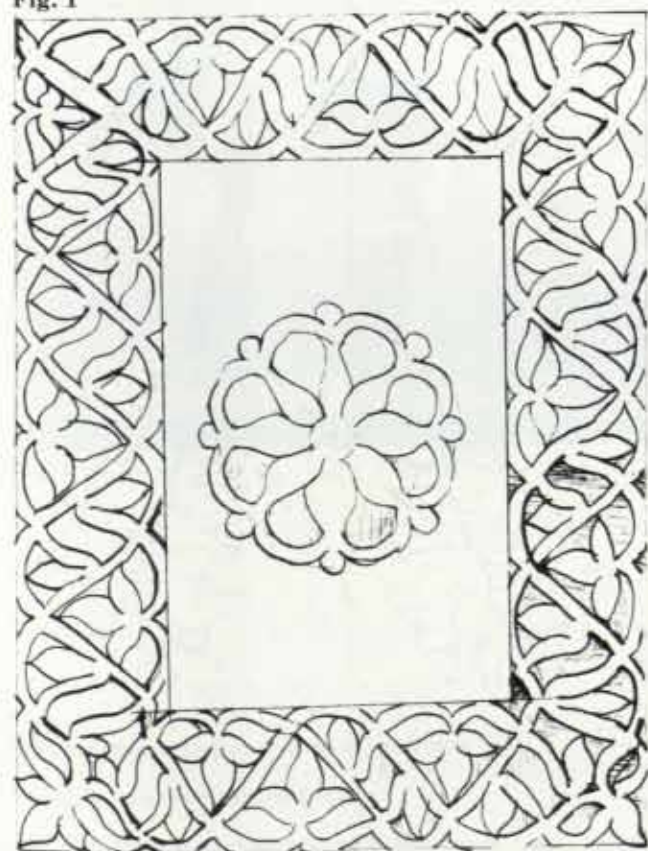


Fig. 1

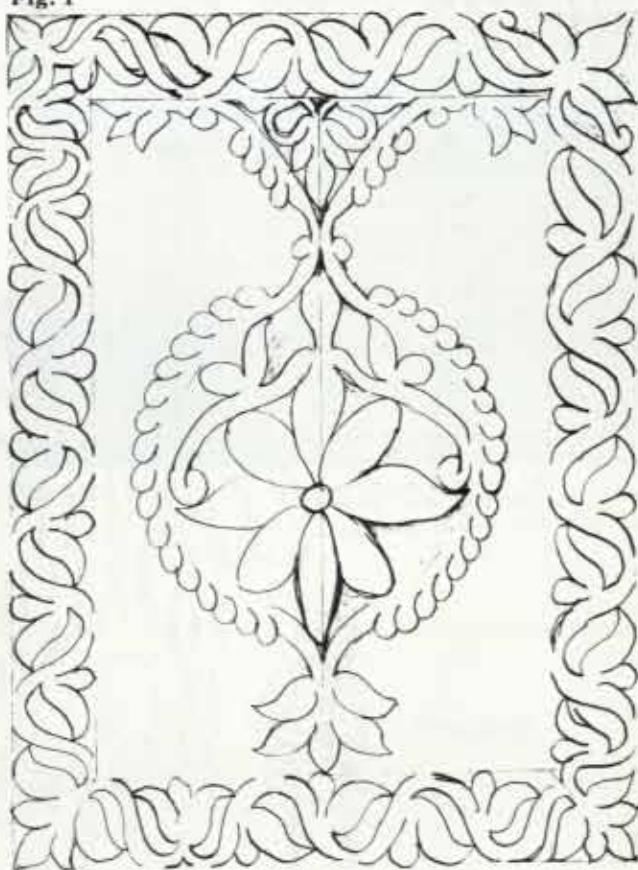


Fig. 2

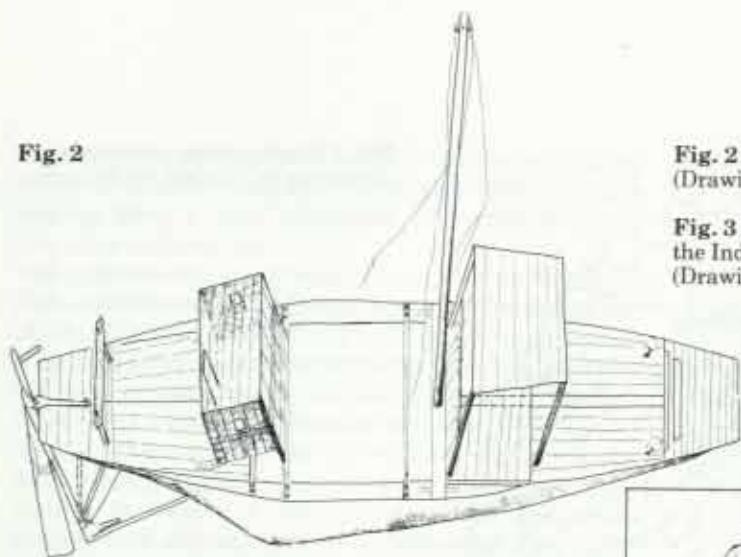


Fig. 2 Isometrical view of a typical Indus house boat.  
(Drawing by Susanne Walter after G. M. Shar).

Fig. 3 Sketches illustrating a boat inauguration ceremony on the Indus.  
(Drawings by G. Mustafa Shar).

Fig. 3

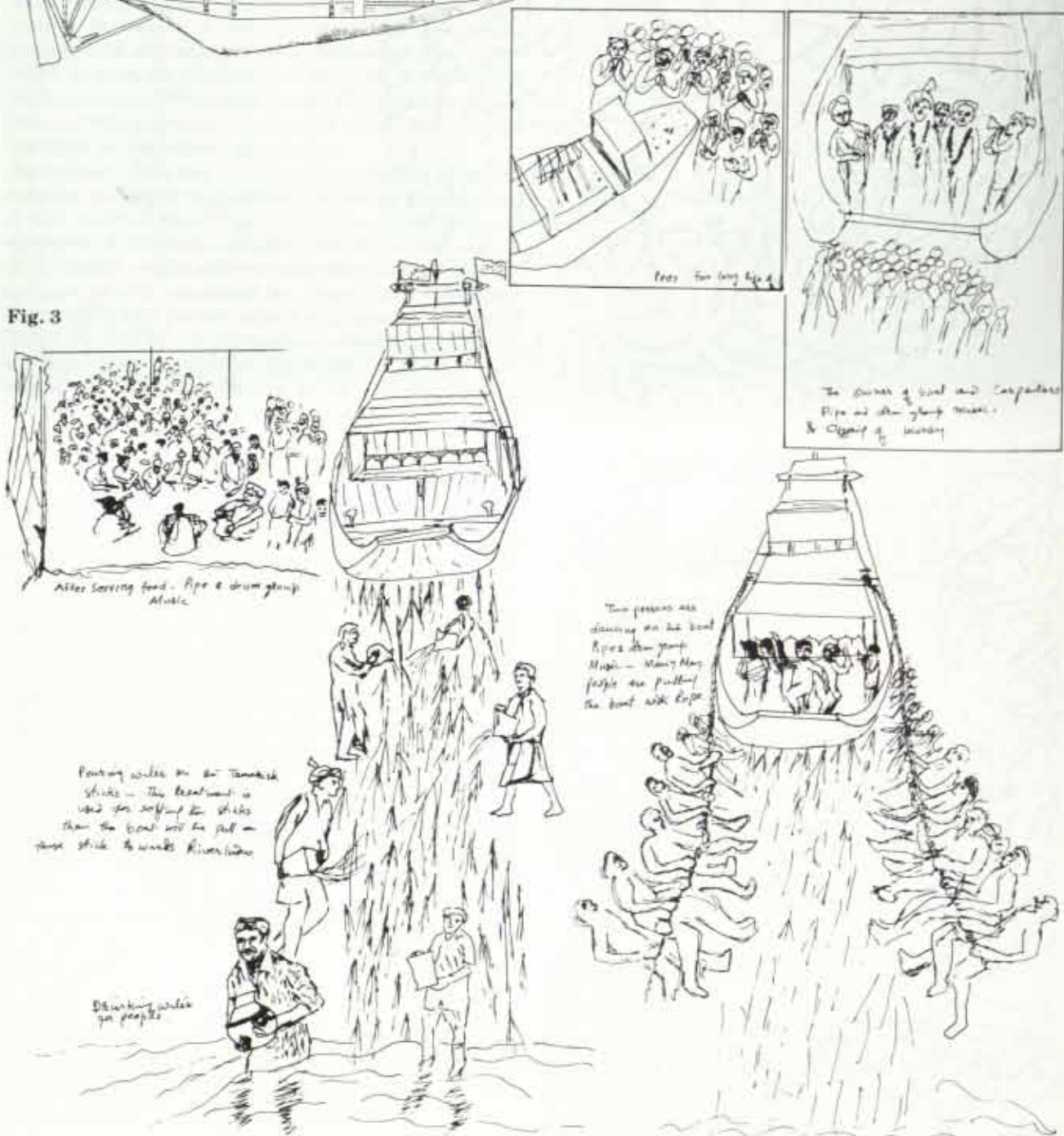




Fig. 4



Fig. 5



Fig. 6

Fig. 4 A Mohanna house boat on the Indus.

Fig. 5 Ferries crossing the Indus.

Fig. 6 A Mohanna village on the Indus.



## Boats on the Indus

Salma Sultana Begum  
Custodian Archaeological Museum  
Mohenjo-Daro

On February 6th 1982 I visited an island in the Indus river together with some members of the team of Dr. Michael Jansen from the Research Project Mohenjo-Daro. There were many boats and the fishermen, the owners of the boats, were standing beside them. Together with Alexandra Jansen I asked for permission to enter the boat of Mr. Mohammad Usman. He told us the name of the boat was "*Beri*" in Sindhi language.

A whole family lives on such a boat and the cabin (called "*Tarro*") is used for sleeping at night but also for sewing and other domestic work during the day. When a child is born, this also takes place in the inner chamber, without a lady doctor's help, but only that of the old women of the community.

All the men, women and children of the family live on the same boat. Even a baby's cradle called "*Pingho*" will be hung from the ceiling. The left side of this section is reserved for storage of food, such as grain, sugar and rice, and a clay oven to cook on, thus it functions as a kitchen. The upper part of this section is called "*Khattaro*" likewise the corresponding part on the right-hand side, but here the family keeps its personal belongings.

The most interesting part is the cabin floor, the "*Tarro*", which is covered with embroidered pillows and hand-made bed sheets of multi-coloured cotton quilts, in such a way that the place gives the impression of a drawing-room.

I asked Mohammad Usman's wife, Rahmat Jan, about her hobbies. She uses her leisure time for weaving mats that they put on top of the roof as a shelter against sun and rain. She also makes the cotton quilts, called "*Rilli*", caps with embroidery and glasswork, called "*Balochi Topi Sindhi*", covers for cushions and table cloths ("*Sagi*"), vests called "*Ganji*", fans ("*Vijno*"), traditional dresses ("*Shalwar qamiz*") and "*Gaji*", the embroidered collars for shirts. The men in turn are concerned with producing the following articles:

1. "*Sindhi juti*" (Chappal)
2. "*Yaktara*" (musical instrument)
3. Bullock cart
4. "*Pingho*" (cradle)
5. "*Khaat*" (Charpoi)
6. "*Sindhi ajrak*" (shawl)

Asking about how they finance the raw material for these products I was told by one fisherman, Mr. Ghulam Rasool, that the contractors for whom they work provide the material and pay a charge for each article produced by the fisherman's family.

Except for the mats, everything is produced inside the cabin. I asked Mr. Usman's sister, Sahib Khatoon, how the marriage ceremony takes place in such a small cabin. She answered that on such occasions they borrowed any available boat from neighbours and relatives. The women guests will sit in the "*Tarro*" and the men outside on the bow ("*Aggal Takhto*") or the stern ("*Pachal Takhto*"), "*Takhto*" meaning board. I wanted to find out from Mr. Usman whether all the fishermen were relatives. The answer was that they are neighbours, but they all have the same name "*Maachi*", which means "men who catch fish".

The interior of the boat is decorated with woodcarving, which is called "*Chitr*" and the different floral designs have various names.

Normally the front outer section of the boat is called "Aggal Takhto" and it is an empty space to keep their articles for sale. The stern "*Pachal Takhto*" is decorated with multicoloured flags called "Add", "Qalmi", and "Seer". Here they also keep their pet birds. The upper roof is called "*Majjo*". It is a sitting area and the family also sleeps there in summer. It is decorated with the "*Rilli*" bed sheets and pillows. The whole area is covered with mats as a shelter ("*Pakkho*") to protect the boat from heat and rain. "*Mir Bahar*" is the sailor, "*Wange*" the rope and "*Bhilli*" the anchor.

As was already mentioned, the main source of income is fishing. From 1982 on the fishermen started to send their goods to Quetta, which hopefully improved their earnings considerably. Furthermore they take tourists for a boat trip on the river whom they charge with thirty to forty rupees. Local people like businessmen from Kandyaro or Nawabshah, who have to cross the river daily, are not charged. They pay with natural goods such as, for example, grain. They take their grain bags, goats, cows, bulls and even camels with them. For each camel they are charged with forty rupees.

At times of high water level in June/July the boats have to take a longer distance to cross the river; then the charge amounts to ten rupees per head, except for children, whereas in the rest of the year the charge is five rupees.

If it becomes too dangerous for the fishermen to live on their boats they move to Kandyaro, Nawabshah, Balharji or Hassan Wahan where they build temporary huts from wood and the above mentioned mats. But they continue to go fishing.

#### Boat Inauguration Ceremony on 13<sup>th</sup> of May, 1982

When we reached the river banks there were already hundreds of people who gathered round the musicians and folksong singers. In a hut or tent made of reed and decorated cloth we recorded only small parts of each song as only one single tape was available. But important moments like during the pulling of the boat were recorded entirely. The different songs are recognizable by their changing sound. The texts run as follows:

1. "*Qabar meen Kursi hundi Moula Amir ji*". It is a religious song and means "I will be the chair of Hazrat Ali in the grave, Hazrat Ali will help and save in the grave".

2. "*Dil ji dil Khay Khabar — Qurib kayo hui piara Qurb Kayo huyoi dost: Tuheñja thora na Lahyan*" is a romantic song.

3. "*Warandy neer Hazaran — Haklan Maran. Taidy karan yar piara Tady Karan Dost*" means: "Tears are coming out for you, my friend".

4. "*Tuñ Samo, helly auñ ghandhery muñ meen aiban Lākh*", means: "You are Samo (i. e. a superior Mohanna caste), I am a fisher and in me are a hundred thousand faults." It is the song of Muri, the fishermaid who became Jam Tamachi's queen.

5. "*Kadhee chad Arman Andar maun — Matan Mohammad Wajay Waree*", is a song about a myth, when Iman Hussain awoke two dead sons of a pagan lady with the miracle of Muhammad. She converted and became Muslim. The text means: "Leave sorrows from your heart, may not Mohammad go back".

6. "*Bairi Lah, Lagae wa'o gajka ludan tha*" means: "Pull and keep your boat in the river, with wind the flags of boat should wave". This song is about boats, it is a prayer for boats and contains the names of Pirs and Murshids and joking sentences.

Then the ceremonies for the boat inauguration start, people are talking and the drum group prepares its performance. We recorded more songs:

7. "*Jamalo*", a humorous song with jokes.

8. "*Dil Bichit satay Yar Tairy milny noon*" is a piece of music for flutes and drums.

After praying there follows another piece for flutes and drums and the blessing of the boat. Then a turban is tied around the carpenter's head and the owner has many currency necklaces. All the guests are in a very happy mood. The pipe and drum music stops while they give money to the owner of the boat: "*Panj Rupy Sultan*", Sultan gave five rupees.

After this financial contribution suddenly the music stopped again. There was a big bird in the waters of the Indus and one Mohanna went and shot it with a gun. Later the owner, the carpenter and two dancers are on the boat. The music has a magical influence on the people, they are shouting: "Pull, pull again!" Sometimes they are repeating sequences of the song "*Ya Ali*". Two groups are pulling the boat, each of them about forty to fifty people. They compete with each other. Each group is pulling on a thick rope which is attached to the boat. Sindhi dance and flute and drum music creates a certain spirit. When the boat is near to the water of the river Indus everybody is alert because of a game: There are about five kilo sweets on the boat and the one who first enters it as soon as it is in the water will win the prize. One of them was quicker than the others and had entered the boat secretly from the side. So he wins and gets all the sweets.



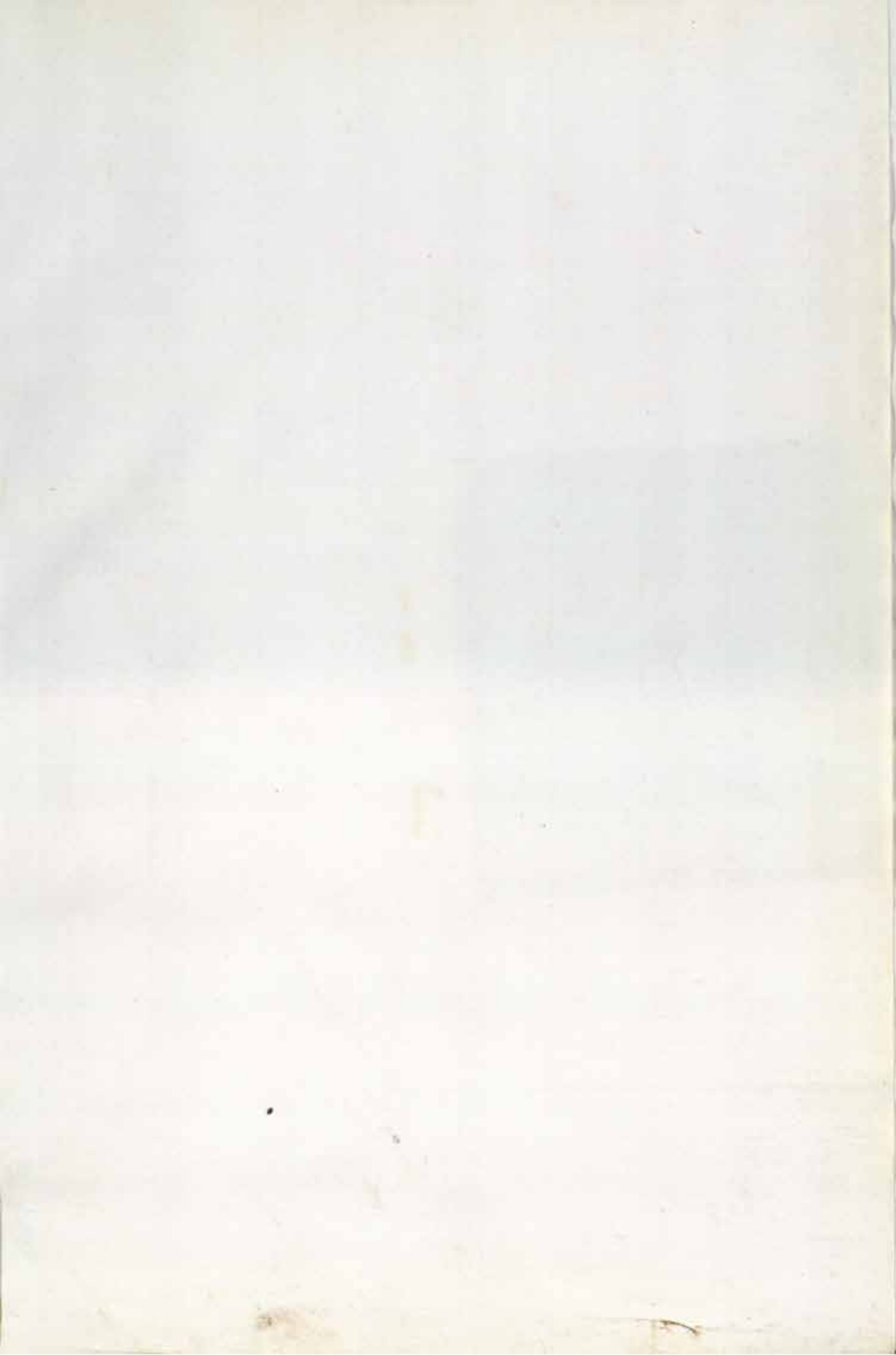
Fig. 1 Mohanna boat on the Indus.

Fig. 2 Mohanna fisherman.



महेंजोदरो,

Excavation — Mohenjo daro  
Mohenjo daro — Excavation





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